

193

THE FOSSILS AND ROCKS OF EASTERN IOWA

A Half-Billion Years of Iowa History

by

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I N T R O D U C T I O N

This Guide is designed for the teacher and the amateur collector. It describes the rock units and fossils in eastern Iowa, and lists a number of collecting localities. An attempt is made to present a background of the geologic history of the state in order to make fossil collecting more meaningful. Fossils should be thought of as remains of organisms that lived in an environment, and should be viewed within the context of earth history, rather than as isolated objects in a collection.

It is assumed that the reader is familiar with some of the basic concepts of biology and geology. Since several excellent books are available in inexpensive editions, an attempt has been made to avoid duplication of material which is readily obtainable elsewhere. If you are completely new to geology and fossil collecting, two books are recommended most highly: the Golden Nature Guide to fossils by Rhodes, Zim and Shaffer, and the Barnes & Noble Everyday Handbook on the same subject by Matthews. Both these books are titled "Fossils", and both are paperbound editions. (see p. 230).

The Golden Nature Guide is illustrated with color paintings, and is particularly useful for identifying fossils. The

book by Matthews covers a wealth of subjects of interest to the collector, including preparations and display technique, hints on collecting, geologic and biologic background, and excellent appendices with lists of museums, dealers, a glossary and an annotated bibliography. For the price, these are the best books available for the teacher or collector at any level.

Some of the stratigraphic nomenclature used in this Guide may be unfamiliar, as may some of the particular difficulties facing the professional geologist.

Assemblages or sequences of rocks were originally defined and grouped by the extent or size of the unit. To a degree, this extent reflects time, thicker sequences of rocks having, in general, taken longer to form. Early geologists soon realized this, and defined their categories of rock-unit subdivision as time-rock units. The largest of these is the System, the next the Series, and then the Stage. The purely time terms which correspond to these are the Period, Epoch, and Age, respectively. Periods are grouped into Eras (such as Paleozoic, Mesozoic, Cenozoic, and so on), and the Eras are generally grouped into two Eons: Cryptozoic (all those before the Cambrian Period, the first period of the Paleozoic

Era) and Phanerozoic (those from the Cambrian to the present).

Although very early workers used rock terms such as System without any time connotation (the Cambrian System, for instance, was originally defined as all those rocks above the top of a particular bed of rock and below the base of another bed), the realization that an amount of time was associated with the formation of these rocks, and the use of System, Series and Stage as time-rock terms led to the assumption that the boundaries of these rock units represent "time-planes". However, since almost all rock units are formed, not instantaneously, but over a period of time; and since the geographic area in which any given rock unit is being formed may shift with time, the boundaries or contacts of these unit may not be "parallel to time" -- that is, they may not be of the same age throughout their areal extent.

It is therefore necessary to have terms to describe rock units which have no time connotations. Such terms are the Group, Formation and Member, in decreasing size order. These are formal stratigraphic terms, and there is a complex set of rule regarding their use. In a general way, the Formation can be thought of as the basic unit -- a

sequence of rocks of uniform, or uniformly varying lithology. Such a unit might be a limestone, a sequence of alternating limestones and shales, or an assemblage of sandstones, siltstones and shales in which the amount and size of the sand and silt particles decreases, and the amount of clay material increases uniformly upward..

Formations may then be combined into Groups or subdivided into Members on the basis of their lithology. A Formation can also be thought of, from a practical viewpoint, as the smallest unit that can be readily mapped at the scales commonly in use on the U. S. Geological Survey maps. The term "beds" is generally an informal one, which may be used to refer to very small units, or to any rock unit for which formal designation is unestablished or unnecessary.

It is a curious fact of the history of geology that most of the time-rock units were defined on the basis of unconformities -- that is, breaks in the sequence of rocks.

Such breaks were formed during hiatuses, periods of erosion or nondeposition -- that is, during time not represented by any accumulation of rock in the area where defined.

Geologists were thus in the position of attempting to define the whole continuity of time in terms that defined part of that continuum out of existence. This has led to a number

of problems concerning the establishment of time and time-rock unit boundaries in parts of the world other than those in which they were defined. Some of these problems will be discussed later in relation to the geologic history of Iowa.

It is generally assumed that the evolutionary processes among plants and animals take place at a uniform or nearly uniform rate and have done so in the past, so that the types of organisms found in a rock reflect the age of the rock within the limits imposed by environment and preservation. Organisms which evolved rapidly (and therefore have a narrow range through time), were distributed widely, and were readily preserved can therefore be used as age indicators, or index (guide) fossils.

The type of time assignment we have been talking about in the above presentation is purely relative; no particular number of years is assigned to any of these time or time-rock units. They are used only to indicate that a particular rock unit is older than, younger than, or about the same age as, rocks in the area where the time-rock unit was defined. All of these time-rock and time units have now been redefined in terms of their contained fossils

instead of unconformities, but they are still relative terms.

At the time these units were defined, it was not possible to establish the age in years of any group of rocks. Now, using "radioactive decay clocks" of several naturally occurring radioactive substances, it is possible to place absolute dates (in years) on a number of particular rock units in the geologic column, and to extrapolate from them a time-table of geologic history. The earliest Cambrian rocks are known to have formed about 600,000,000 years ago; somewhat younger Upper Cambrian rocks in Iowa were deposited approximately 525,000,000 years ago. The Cambrian-Ordovician boundary is placed at about 500,000,000 years ago, the Ordovician-Silurian boundary at 425,000,000 years ago, the Silurian-Devonian at 405,000,000, the Devonian-Mississippian at 345,000,000, and the Mississippian-Pennsylvanian at about 310,000,000 years ago. These dates are all, of course, subject to errors of measurement (10% accuracy is considered very good); they are, however, the best available with present means. For a very clear and interesting discussion of relative and absolute dating, and how radiogenic dating is done, see Rutten, Geological Aspects of the Origin of Life on Earth, Elsevier Co.

This Guide is divided into two parts. The first deals with the general history and life of the first five Periods of the Paleozoic Era in Iowa, with a section listing the area of outcrop for rocks of each System, and another with several collecting localities for fossils and stratigraphic exposures. The second part is a series of nine field trips, arranged stratigraphically, and designed to permit at least one field trip to be within reasonable distance for collectors in all parts of eastern Iowa. Each trip has at least one stop at which fossils may be collected. If the trips are taken in sequence, a reasonably complete picture of the Lower and Middle Paleozoic stratigraphic sequence will emerge. In addition, particular aspects of paleontology, paleoecology, lithology, stratigraphy or geologic history are emphasized on each trip. Some trips are designed to take a whole day, and some a half-day. If circumstances permit, any number of trips can be taken together, or different stops may be substituted. Plates illustrating fossils referred to in both sections will be found between the two sections, and a geologic map and columnar section for Iowa may be found in the rear pocket.

If you are going to lead a group on one or more of the suggested field trips, be sure to check the route and visit



all stops yourself in advance. This will insure that all routes and sites are open, there will be sufficient time, and that you understand the exposures. Arrange with quarry- and land-owners ahead of time if you are going to bring a trip on their property.

Equipment used for collecting is inexpensive and can be secured readily: a rock-hammer of some sort, either "hard-rock" (pointed end) or "soft-rock" (chisel end -- a mason's hammer may also be used); cold chisels; strong sacks, pencils (3H), pad of paper for labels, newspaper and tissue for wrapping specimens, and a hand lens about 10X magnification) are basic. You should also have a notebook, and carefully record the pertinent data about the localities you visit and the specimens you secure, if your collection is to have any scientific value. A fossil without data as to where it was collected and at what horizon (what rock layer) is merely a curio. This is a particularly important point for teachers to impress upon their students, along with the ordinary rules of courtesy and safety on field excursions.

In addition to regular road maps, and, if possible, a compass, a set of the County Maps issued by the State Highway Commission at Ames is recommended highly. County

roads are not always well labelled, and although small portions of County Maps are included in the Guide, they will not help you if you get lost off the map area. In addition, many quarries not described in the Guide are shown on the County Maps (although a number of abandoned quarries are not shown); you may wish to investigate some of these quarries. (Always cooperate with quarry owners and operators). County Maps are published at scales of  $1/4'' = 1$  mile,  $1/2'' = 1$  mile, and  $1'' = 1$  mile. The  $1/4'' = 1$  mile maps are most portable for field work, but are also least legible; the  $1/2'' = 1$  mile are suitable for home, school or club use. The maps in this Guide were cut from the  $1/2'' = 1$  mile series, and have been reduced by  $1/2$  for publication, so that  $1/4'' = 1$  mile.

Wear sturdy clothes when going on field excursions.

Strong shoes or boots are important, and legs should be protected. Do not attempt to climb quarry or steep natural exposures unless you are experienced. Never climb alone. Quarry walls have generally been shattered during blasting and are particularly treacherous. Do not collect beneath overhangs unless you have a hard hat; even then, it is not advisable. Be particularly careful after rains and during spring thaws; shales become waterlogged and slump, and

shattered or heavily jointed rock may be pried loose by frost action. Shield your eyes when hammering rock; if possible, use protective goggles. Always take a first aid kit, including a snake-bite kit, on field trips. (Always be alert to the possible presence of venomous snakes; watch where you put your hands and feet.) You may wish to carry a penknife and an acid bottle for testing the hardness of rocks and ascertaining the presence of carbonates. If so, be sure never to climb with knife or acid bottle open. A plastic dropper-bottle for the acid is advisable.

Please do not unnecessarily deface the outcrops you visit. You will be able, at many of the suggested stops, to see specimens too large to extract. It is more courteous, and of more educational value, to leave such specimens undisturbed for others to see, than to risk ruining them in unsuccessful collecting attempts. If there are specimens which appear to be of scientific value that you cannot identify, cannot extract, or want to know more about, contact a competent authority. Staff members at those Colleges and Universities in Iowa having geology departments (State University of Iowa, Iowa State University, Cornell College, Simpson College, State College of Iowa, Drake University and Upper Iowa University), and the geologists of the Iowa Geological

Survey in Iowa City are generally willing to examine any specimen that may be of genuine geologic interest.

In addition to securing permission (preferably in advance) from landowners on whose property you collect, be sure to leave all gates as you find them; do not frighten livestock; do not litter; do not build fires without permission; and be careful of fences -- avoid damage both to yourself and to the fence.

The rocks of Iowa contain as abundant, as varied, and as accessible a fauna as any in North America. Happy collecting.

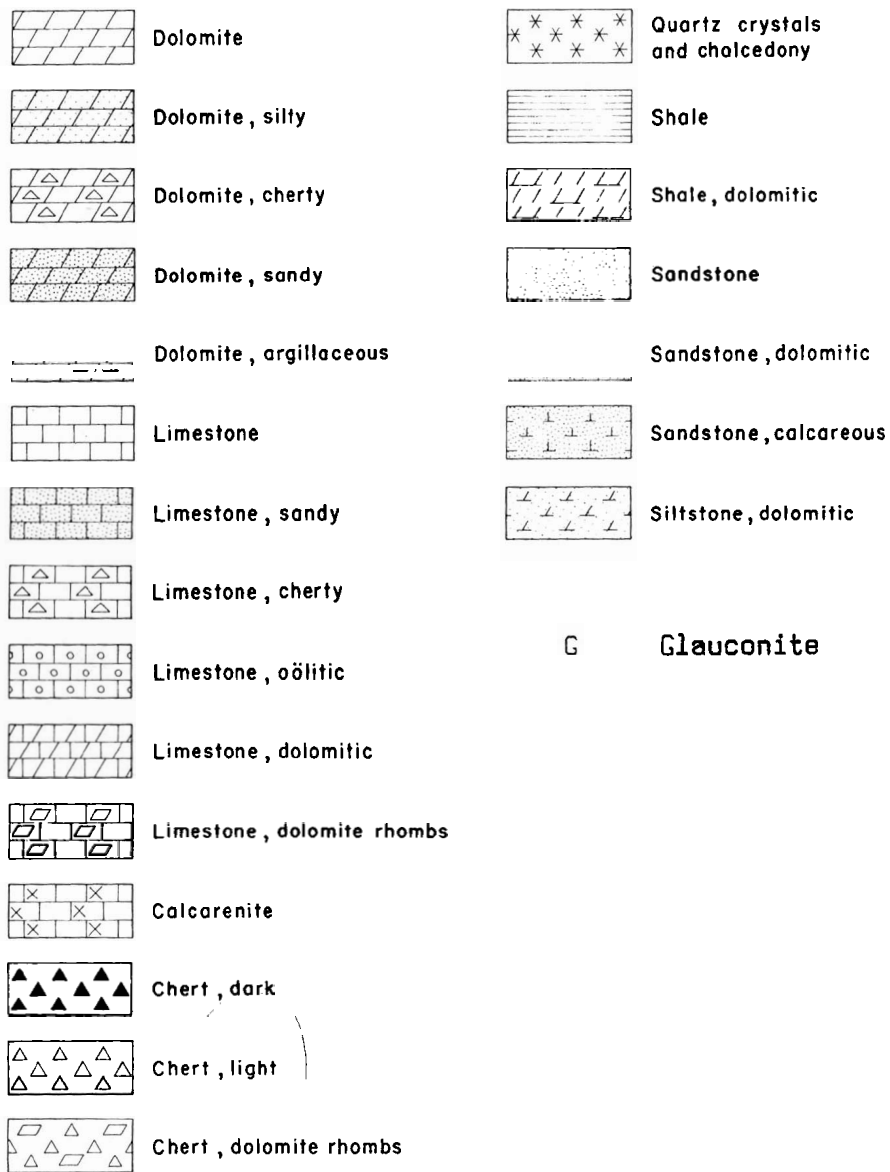


Fig. 1. Symbols Used in Columnar Sections

PART I

The Rocks and Their History



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C A M B R I A NGeneral Remarks

Cambrian deposition in Iowa appears to have begun with the Upper Cambrian (St. Croix Series). The Cambrian formations of Iowa are mostly sandstones, with a few dolomites and siltstones or shales. This sequence is thought to represent a return of the seas over the continent after a long period of uplift and erosion at the end of the Precambrian. The seas returned earlier to other parts of the continent, for Lower and Middle Cambrian deposits occur in the Appalachian and Rocky Mountain areas.

The Upper Cambrian formations (rock units) of Iowa are shown in the accompanying geologic column (in rear pocket). Although fossils are common in some of these formations in Minnesota and Wisconsin, they are rare in Iowa. Some are reported from the Lodi Formation at Lansing (see Trip I, Stop 1).

A striking element of the Upper Cambrian in Iowa is the green sand of the Franconia Formation. The green color is caused by the mineral glauconite, which is mixed with the quartz of the sandstone. The glauconite is thought to indi-

ate slow accumulation of sediments in a marine, chemically reducing environment. The glauconite may have been concentrated by waves and currents after it was formed.

In general, dolomite beds and dolomitic sandstones are more common in the uppermost Cambrian and Lower Ordovician, whereas quartzose and glauconitic sandstones predominate in the lower part of the section. Compare, for instance, the section for Fire Bell Hill (Fig. 8) with that three and a half miles west of Lansing (Fig. 2).

### Life of the Cambrian

In the Cambrian are found the oldest abundant fossils. Although life undoubtedly began long before this time, Precambrian fossils are very rare indeed, and are generally poorly preserved and of little or no use in time correlation (determination of the relative ages of rock units).

Trilobites are so characteristic of the Cambrian that many textbooks refer to it as "The Age of Trilobites". The base of the Cambrian was originally defined as the point of lowest occurrence of the trilobite Olenellus thompsoni, and most Cambrian correlation is based on various trilobite species.



Inarticulate and articulate brachiopods are common in Cambrian rocks. Snails, clams, primitive echinoderms and graptolites, ostracods, sponges and the extinct sponge-like archaeocyathids also occur. Some Cambrian limestones are composed largely of algal structures.

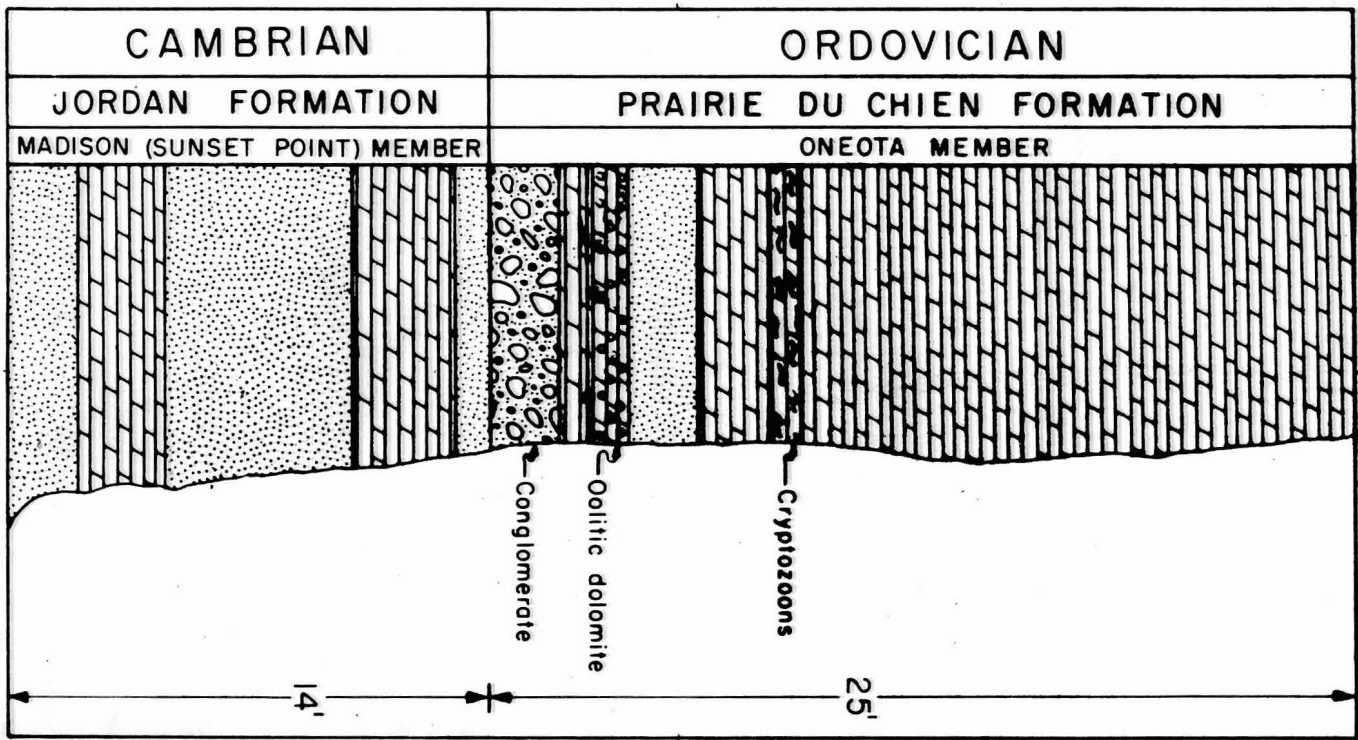
### Area of Outcrop

Cambrian formations crop out in Iowa only in the extreme northeastern corner of the state, in Allamakee County and extreme northeastern Clayton County. They extend beneath the surface over most of the state, however. The Jordan Sandstone is an important aquifer (water-bearing rock stratum) over much of the state. As a consequence, many wells have been drilled into this formation, thus providing much information about the subsurface distribution of Cambrian rocks.

### Localities

A Cambrian section is exposed at Fire Bell Hill, Lansing, Allamakee County [SW 1/4, NE 1/4, SE 1/4, Sec. 29, T. 99 N., R. 3 W., Allamakee County](see Trip I, Stop 1). The Franconia, St. Lawrence and Lodi Formations are exposed here.

Fig. 2. Cambrian-Ordovician Contact, West of



On State Highway 9, about three and a half miles west of Lansing, the contact between the Cambrian and the Ordovician rocks can be seen (see Fig. 2). A thin zone of conglomerate at the base of the lowermost Ordovician Oneota Member of the Prairie du Chien Formation marks the contact with the uppermost Cambrian Madison (or Sunset Point) Member of the Jordan Sandstone Formation.

The latter formation is well exposed between Marquette and McGregor, Clayton County. The Cambrian-Ordovician contact occurs about a mile and a half north of the bridge across the Yellow River on State Highway 13 [SE 1/4, Sec. 28, T. 96 N., R. 3 W., Allamakee County]. From there south to the town of McGregor, cliffside exposures are of the Jordan Sandstone. This unit can also be seen in the bluff across the street from the Scenic Hotel in McGregor.

ORDOVICIANGeneral Remarks

The Ordovician formations of Iowa are largely limestones or dolomites with interbedded shales and some thicker shale units. There are a few sandstones, of which the St. Peter Sandstone is the thickest and best known. This sequence probably represents deposition in shallow seas of the continental interior. Many of the formations are highly fossiliferous and contain a varied and well-preserved fauna.

The six main divisions of the Ordovician System of Iowa are shown in the geologic column (rear pocket). A major break in the sedimentary sequence occurs between the Prairie du Chien Formation and the St. Peter Sandstone. During the time represented by this break, an erosion surface of considerable relief developed on the Prairie du Chien rocks, so that both they and the overlying St. Peter vary in thickness. In some areas, well records indicate that the St. Peter rests on the St. Lawrence Formation (Upper Cambrian); an erosional surface of 450 feet relief is developed in Clinton County. Another period of erosion followed deposition of the Maquoketa Formation, with the development of over fifty feet of local relief.

## Life of the Ordovician

The Ordovician was a time of great biologic diversification and by the end of the Period, most major groups of marine invertebrates had appeared. The articulate brachiopods and nautiloid cephalopods flourished, and trilobites continued to be abundant. Graptolites became numerous, and where available, are used as standard guide or index fossils for the Period. (An index or guide fossil is one which may be used to determine the age of the rock in which it is found; such fossils generally have short time-distribution and a wide geographic distribution.) The peculiar sponge-like Receptaculites appeared, and is used as an index fossil for the Galena Formation in Iowa. Both solitary and colonial corals are common but do not form reefs. The oldest fish remains are found in Middle Ordovician rocks, but fish are not known in the Ordovician of Iowa. Conularids, pyramidal organisms with chitino-phosphatic skeletons, possibly related to the living jellyfish, also appear in the Ordovician, and are occasionally found in Iowa.

## Area of Outcrop

As can be seen from the geologic map of Iowa, Ordovician rocks crop out in a northwest-southeast trending belt, most-

ly in the northeastern corner of the state, in Winneshiek, Allamakee, Fayette, Clayton and Dubuque counties; to a lesser extent in Jackson and Clinton counties (along the Mississippi River), and in an isolated patch in Bremer County. Many road cuts and ravines in this area provide excellent exposures and good fossil collecting. Galena, sphalerite and other minerals are available in the Lead-Zinc District around Dubuque.

The St. Peter Sandstone is one of the upper Mississippi Valley's most important aquifers, and because of the number of wells drilled to this horizon, much is known about the subsurface distribution of this and overlying formations. Except where locally removed by erosion, the Ordovician rocks continue in the subsurface over most of the state.

### Localities

Some of the more readily available and richly fossiliferous Ordovician rocks occur in the vicinity of McGregor, Clayton County. In particular, the road cut on State Highway 13 west of town and on State Highway 340 south of town are easily accessible and provide good collecting. The State Highway 340 locality (the "Pike's Peak Roadcut") is described in more detail later (Trip I, Stop 6). The section ex-

posed is from the Willow River Dolomite to the Prosser Dolomite.

This same section is exposed in Pike's Peak State Park, although no collecting is permitted there. A walk down the cliff path to the Sand Caves is instructive. Here, the St. Peter Sandstone, in which the caves are developed, is thick and spectacularly colored. Most of the other formations, with the exception of the Specht's Ferry Shale, are well exposed in a nearly vertical sequence. Steps are cut into the trail, which is arduous but not dangerous, and it is easy to estimate thicknesses (see Fig. 15). Several Receptaculites can be seen in the trail itself near the top of the bluff.

Similar Ordovician sections are exposed in road cuts both north and south of the towns of Guttenberg and Millville, Clayton County (see Trip I, Stops 4 and 5).

Northwest of Graf, Dubuque County, a small quarry on the north side of County Road C, one-half mile west of the Chicago Great Western tracks [SW 1/4, Sec. 16, T. 89 N., R. 1 E., Dubuque County] exposes the upper part of the Galena Formation. About five feet of the Stewartville Member occurs at the base of the quarry; the rest of the face ex-

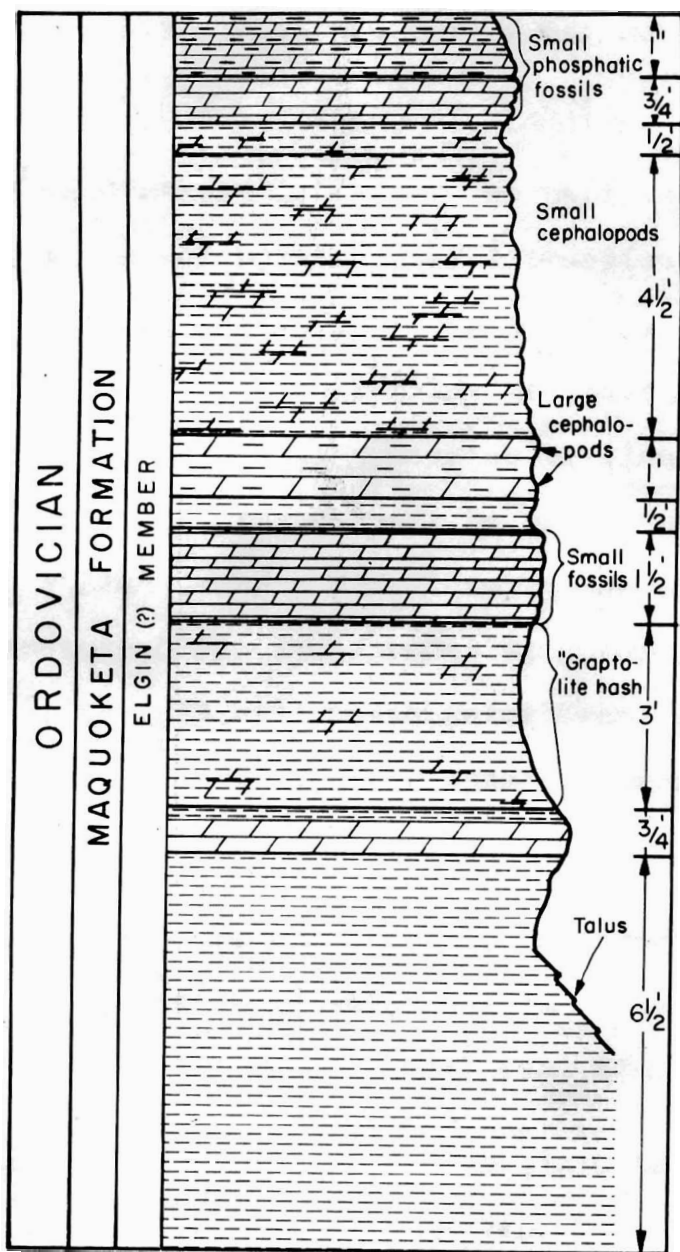


Fig. 3. Section at Graf



poses the Dubuque Member, with about two feet of the Maquoketa Formation at the top of the quarry. Fossil collecting is poor, and the quarry walls are hazardous, but a large pull-off area makes this a good brief survey stop. In particular, note the Galena-Maquoketa contact. This contact also occurs on State Highway 9, about twelve and a half miles west of Waukon [SE 1/4, SW 1/4, Sec. 4, T. 97 N., R. 7 W., Winneshiek County], where the Stewartville and Dubuque Dolomites are more fossiliferous. The Maquoketa occurs at the top of the cut north of the road, but is largely overgrown.

About one-quarter mile southwest of Graf, Dubuque County, in a road cut which also carries the tracks of the Chicago Great Western Railroad, the lowest beds of the Maquoketa Formation (the Elgin Member) are exposed in a very famous collecting site (see Fig. 3). There the basal "Depauperate Zone" may be found; the fauna consists of miniature forms, mostly pelecypods, gastropods and nautiloid cephalopods, about one-tenth normal size. Above this zone is the Diplograptus (Glyptograptus) peosta Zone, from which uncrushed graptolites may be secured. The top of the cut includes the "Orthoceras" Zone, in which there is a five-foot layer so densely packed with straight nautiloids such as Isorthoceras

socialis as to be a veritable "cephalopod coquina". The unpaved road is not heavily travelled, and the talus slope beneath the cliff is easily climbed, and is also the source of excellent fossils. At Graf, the "Depauperate Zone" is generally covered by the talus, but the Zone is exposed in the road ditches and fields adjacent to the Little Maquoketa River northeast of the town [SE 1/4, NW 1/4, SE 1/4, Sec. 20, T. 89 N., R. 1 E., Dubuque County].

The numerous road cuts in the vicinity of Decorah, Winnebago County, provide excellent exposures of various parts of the Ordovician sequence, largely in the Decorah and Galena Formations. Fossils may be secured from many of these cuts, especially along new U. S. Highway 52 just north of Decorah, although they are not as abundant here as farther south.

In stream cuts along State Highway 172 between Elgin and Clermont, and along Little Turkey River south of Elgin (and in other stream cuts in this vicinity), the Elgin and Clermont Members of the Maquoketa Formation are well exposed. This has long been a well-known trilobite area. (see Trip I, Stop 3).

The topmost beds of the Maquoketa Formation, and the Ordo-

vician-Silurian contact, may be seen at Bellevue State Park, Jackson County (see SILURIAN, and Trip II, Stop 3).

The Depauperate Zone is to be found in the bed of Mill Creek in the park, but it is not suggested that a group attempt to collect in this locality.

The Ordovician-Silurian contact also occurs on State Highway 150 south of Eldorado. The Clermont and Fort Atkinson (the middle two) Members provide good fossil collecting here, but the uppermost member (the Brainard Member) and the contact with the Silurian are generally hard to find without digging.

The best way to find the upper beds of the Maquoketa Formation (the "Cornulites Zone" of the Brainard Member, named after a small, snail-like organism of uncertain biological relationships), is to keep track of new highway construction or road grading in the vicinity of the Ordovician-Silurian contact marked on the geologic map, and check these areas yourself.

S I L U R I A NGeneral Remarks

The erosional surface developed on the Maquoketa Formation indicates that the sea withdrew from Iowa for an interval at the end of the Ordovician. The first Silurian formation shows an irregular thickness that inversely matches that of the Maquoketa, being thicker where the Maquoketa is thin, and vice versa.

There are four formations in the Silurian of Iowa (see geologic column). Two of these are commonly referred to the Lower Silurian (Alexandrian) and two to the Middle Silurian (Niagaran). They all appear to have been deposited in shallow, warm seas as limestones, and later altered to dolomite. There are no Upper Silurian formations known in Iowa. Exact age determinations of the Silurian rocks of Iowa are made difficult by differences between the Silurian fossils of Iowa and those of the type areas in eastern United States and Britain. Apparently the seas withdrew again during Late Silurian time.

The Edgewood Formation is a sandy dolomite, variable in thickness, and may have abundant ripple marks, as at Belle-

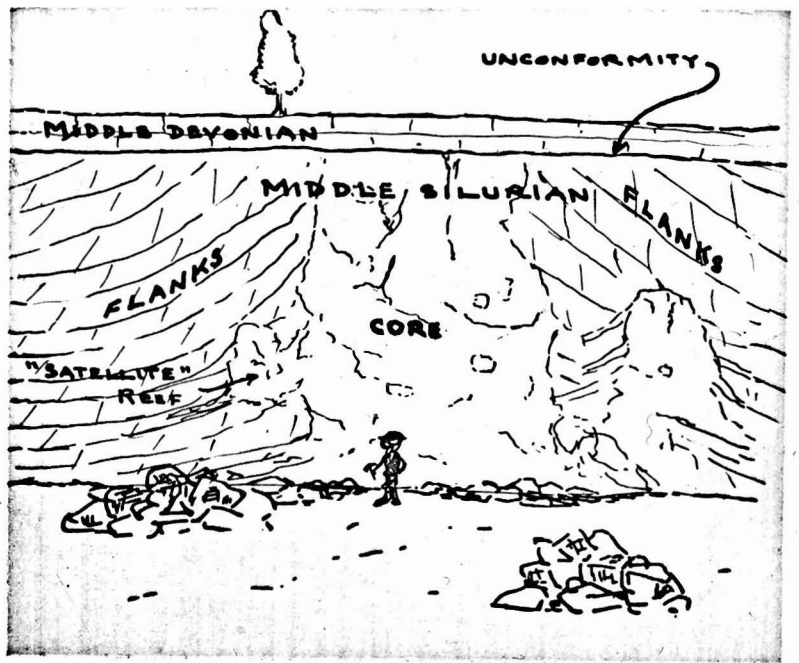


Fig. 4. Sketch of a Typical Bioherm

vue State Park (see Trip II, Stop 3). The Kankakee Formation is noted for its chert bands alternating with dolomite layers. The Hopkinton Formation is generally abundantly fossiliferous; in some localities the fossils are silicified (replaced by silica,  $\text{SiO}_2$ ).

The Gower Formation is characterized by widespread development of bioherms ("life mounds") -- the so-called "coral reefs". Some of these bioherms must have risen to the zone of wave action, for they are surrounded by steeply dipping flank beds of rubble broken from the reef (see Fig. 4). The Iowa bioherms are smaller and more abundant than similar ones in Illinois and Indiana. The structureless core and the steeply dipping flank beds are of a gray or blue-gray dolomite, called the LeClaire phase, that is more resistant to erosion than the horizontal beds of yellowish inter-reef dolomite, called the Anamosa phase. The tops of the reefs have been truncated, presumably by erosion during the later part of the Silurian or early Devonian, and Middle Devonian rocks may now be seen lying horizontally across the crests of the old bioherms at some exposures. Many organisms besides corals -- particularly brachiopods, echinoderms and cephalopods -- lived in and about these "reefs"; fossils are rather sporadically preserved in the LeClaire phase,

many having been removed by solution. There are almost no fossils in the Anamosa phase, but in certain layers, crystal-lined cavities are common.

### Life of the Silurian

Silurian seas contained an abundance of solitary and colonial corals, brachiopods and gastropods. Nautiloid cephalopods were common, as were crinoids and cystoids. Trilobites were less numerous than in the Cambrian and Ordovician.

Graptolites, while relatively rare in limestones, are sufficiently abundant in certain shale units to be used as index fossils.

It is in part because the appropriate graptolite-bearing, shaly rocks do not occur in the Silurian of Iowa that the comparison with the standard or type sections in England and Wales is difficult. There, the rocks are shaly and contain numerous graptolites, different species in different layers of rock, which permit the determination of the relative ages of other Silurian rocks which contain graptolites. However, many of the Silurian fossils of Iowa are similar to those in the Silurian limestones of Europe. (These rocks are called "Gotlandian" by many European geologists.)

The eurypterids, relatives of the horseshoe crab, were most abundant during the Silurian. Fish, which first appeared in the Middle Ordovician, continued to develop, and the first known land animals, scorpions, occur in Silurian rocks.

Lower Silurian rocks in Iowa are sparingly fossiliferous; a few brachiopods and trilobites are known. The Middle Silurian rocks are more fossiliferous, and contain organisms of warm, shallow seas -- the "shelly" animals: brachiopods, corals, crinoids, cystoids and various molluscs, including gastropods and nautiloid cephalopods in the Hopkinton and a similar fauna in the Gower. Trilobites are not common, but do occur. Most of the fossils of the Gower are, as mentioned above, concentrated in the LeClaire ("reef") phase, with corals and stromatoporoids (lime-secreting hydrozoans) dominant in the core of the reef, along with crinoids and cystoids, brachiopods and molluscs. The flank beds contain mostly crinoids, cystoids and brachiopods, with cephalopods and other molluscs. There are generally broken and worn fragments of corals and stromatoporoids on the flanks.

Graptolites, which are, as stated above, rare in the Silurian of Iowa, are known from the Edgewood Formation at Bellevue State Park.



### Area of Outcrop

Silurian rocks crop out in a broad, somewhat triangular patch in parts of Bremer, Fayette, Clinton, Buchanan, Delaware, Dubuque, Linn, Jackson, Cedar, Scott and Muscatine counties, and constitute the bedrock of Jones County. The more fossiliferous Hopkinton and Gower Formations are found near the Devonian side of the outcrop band. Quarries and roadcuts in this area are good sources of fossils and of chert which may be stained with bright red and orange iron oxide.

### Localities

On U. S. Highway 52 south of Millville, the Edgewood, Kankakee and Hopkinton Formations may be seen. (see Trip I, Stop 4). The Kankakee is cherty, and the Hopkinton contains corals. A small quarry on the top of a hill on a road running west from the bridge over Turkey River at Millville [SW 1/4, Sec. 18, T. 91 N., R. 2 W., Clayton County] exposes the Kankakee. Chert, much of it brilliantly stained by iron oxides, may be secured here.

An abandoned quarry on State Highway 3, about three miles west of Colesburg [SE 1/4, NE 1/4, Sec. 2, T. 90 N., R. 4

W., Delaware County] exposes the lower part of the Edgewood Formation, and fossils are reported from this quarry.

Near Centralia, in Dubuque County, on a small road which runs south from old Highway 20 about three miles east of Centralia, silicified corals may be obtained in the shallow residual soil of the road cut. [SW 1/4, NW 1/4, Sec. 7, T. 88 N., R. 2 E., Dubuque County].

At Bellevue State Park, a section starting with the shales of the Maquoketa Formation of Ordovician age through the Edgewood and Kankakee is exposed (see Trip II, Stop 3). Good ripple-marked slabs may be seen near the park entrance on U. S. Highway 52, but collecting within the park is not permitted.

At the Schmoor Brothers Rockdale Quarry, one mile north of Maquoketa [NW 1/4, Sec. 18, T. 84 N., R. 2 E., Jackson County], the well-known Pentamerus beds of the Hopkinton Formation may be seen. The brachiopod Pentamerus oblongus occurs in great quantities in certain layers, and may be up to four or five inches long. These same beds may also be found in a quarry five miles north and one mile east of Onslow, Jones County, on a county road running east off State Highway 136 [NE Corner, Sec. 18, T. 85 N., R. 1 W., Jones

County]. Road cuts and quarries in the vicinity of Scotch Grove, Jones County, carry various silicified fossils -- the chain coral Halysites, other colonial corals such as Helio-lites and Favosites, numerous solitary corals and bryozoans. The unusual crinoid Petalocrinus mirabilis, in which the arms are fused to form five "arm-fans" which must have given the living animal an umbrella- or mushroom-like appearance, has been found in this vicinity. Individual "petals" or "arm-fans" are generally all that are found; they are best secured in the residual soils along road-cuts, or in fields. The "square coral" Goniophyllum pyramidale, which is found only in Iowa and on the Island of Gotland in the Baltic Sea, has also been found in the Scotch Grove area, but is extremely rare. A quarry just north of the town of Scotch Grove, on State Highway 38, has good coral collecting.

A typical bioherm of the Gower Formation may be seen at the Brady Quarry, located about three miles southwest of Tipton, Cedar County (see Trip III, Stop 3).

Similar bioherms are exposed at several quarries in Cedar County and Linn County, such as the Mitchell or Lisbon Quarry (not now working) about one mile south of Lisbon on a county road [NE 1/4, Sec. 23 and NW 1/4, Sec. 24, T. 82 N., R. 5 W., Linn County], and the Hunt Quarry west of Tipton

[Center, Sec. 10, T. 81 N., R. 4 W., Cedar County](see Trip III, Stop 2). A number of crinoids, brachiopods, clams and nautiloid cephalopods may be found at the Hunt Quarry. The quarries at Lime City are also in bioherms. Here there were kilns for lime-burning, and a sizable community developed. The quarries, of which there are several within half a mile, are along Sugar Creek, north of Interstate 80 near the Tip-tion interchange [NW 1/4, Sec. 15, T. 79 N., R. 2 W., Cedar County.

DEVONIANGeneral Remarks

Four major formations in north-central and eastern Iowa are assigned to the Devonian System: the Wapsipinicon, Cedar Valley, Shell Rock and Lime Creek. In addition, there are exposures of two smaller formations, the Sheffield and Applington. Several formations in southeastern Iowa, formerly thought to the lowermost Mississippian, are now considered as Upper Devonian; the Maple Mill Shale and parts of the English River Siltstone are equivalent to the upper part of the Devonian section in north-central Iowa.

Here is illustrated a common problem in stratigraphy: rocks of the same age in different areas may be of different lithologic types, or facies. For example, the Upper Devonian of north-central Iowa comprises about equal thicknesses of limestone and shale, whereas in southeastern Iowa equivalent rocks are dominantly shale with some siltstone. A second difficulty is the assignment of the ages of such rock units, and their correlation (determination of whether or not two or more rock units at different places are equivalent in time and/or lithologically continuous).

Most modern organisms prefer particular environments, although a few can live under a wide variety of conditions. It is reasonable to assume that animals in the past also had preferred environments, and, indeed, we find certain types of organisms in shale, and others in limestones. It might very well be the case that the brachiopods of the Upper Devonian and Lower Mississippian shales might resemble each other more closely than would the brachiopods of Upper Devonian shales and Upper Devonian limestones. The ultimate and most obvious example of this would be the comparison of rocks formed on land (on the floodplains of rivers or in desert basins) with those formed in seas: how would you tell which land animals and marine animals belonged in the same period?

Another problem in determining the ages of the above formations is that the lowest of them, the Wapsipinicon, has few fossils. It overlies a Middle Silurian formation and underlies known upper Middle Devonian rocks (the Gower and the Cedar Valley, respectively), and we can say that its age is somewhere between these two. However, meager fossil evidence suggests that the Wapsipinicon is most probably lower Middle Devonian.

Lack of megafossils (those visible to the naked eye) has

until recently been a problem with the Maple Mill Shale of southeastern Iowa as well. Its age was determined only comparatively recently, when its abundant conodont fauna was studied and proved to indicate an Upper Devonian age.

### Life of the Devonian

The fishes, which apparently originated in the middle part of the Ordovician, and developed during the Silurian, became particularly abundant and varied during the Devonian, and textbooks commonly refer to the Devonian as the "Age of Fishes". Brachiopods and corals, gastropods and pelecypods, crinoids and some other echinoderms, were all abundant in shallow, clear seas. Their remains form the bioherms and biostromes of the limy facies of the Devonian. These "reefs" and "meadows" are well represented in Iowa in the Cedar Valley and Lime Creek Formations. Nautiloid cephalopods continued to flourish, and the first ammonoid cephalopods appeared. Trilobites were less abundant than before, although by no means rare; graptolites had declined considerably and are represented only by the dendroids and a few species of graptoloids (the latter occur only in the Lower Devonian). Land-plants spread widely. Lobe-fin fishes and amphibians also appeared during this period. Spiders, milli-

pedes and insects were probably fairly common, although they are rare as fossils.

### Area of Outcrop

Devonian rocks crop out in a wide, northwest-southeast trending belt, and cover a much greater surface area than those of the Ordovician or Silurian. Reference to the geologic map of Iowa will indicate that Middle Devonian rocks occur at the surface in most of Mitchell, Howard, Floyd, Chickasaw, Butler, Blackhawk, and parts of Kossuth, Winnebago, Worth, Hancock, Winneshiek, Bremer, Fayette, Grundy, Buchanan, Tama, Benton, Linn, Johnson, Cedar, Scott and Muscatine counties.

Upper Devonian rocks make up the bulk of Cerro Gordo County, and occur in parts of Kossuth, Winnebago, Worth, Hancock, Floyd, Franklin, Butler, Hardin, Grundy, Blackhawk, Tama, Benton, Poweshiek, Iowa, Johnson, Scott and Muscatine counties.

Good fossil collecting may be found in road cuts in these counties, but more particularly along the valleys of the Iowa, Cedar, and other major rivers, and in quarries. The Cedar Valley Formation (upper Middle Devonian) and the Shell



Rock and Lime Creek Formations (Upper Devonian) provide the best fossils. Calcite, sometimes in various colors and moderately large crystals, fluorite and pyrite may be found in these formations as well.

Gypsum is found in rocks of Devonian age (probably Wapsipinicon) below the surface in Des Moines County, about 15 miles north of Burlington, where it is mined commercially.

#### Localities

The lower part (Coggon Member) of the Wapsipinicon Formation may be found overlying the Gower Formation (Silurian) at the Brady Quarry (see Trip III, Stop 3). A better exposure of the Wapsipinicon Formation may be seen at a quarry along the Wapsipinicon River, just northwest of Central City [NW Corner, SE 1/4, Sec. 28, T. 86 N., R. 6 W., Linn County] (see Trip IV, Stop 1). The upper few feet of this section may also be seen in the deepest parts of a quarry on U. S. Highway 20 on the east side of Independence [NW 1/4, Sec. 2, T. 88 N., R. 9 W., Buchanan County] (see Trip IV, Stop 2).

A nearly complete Cedar Valley exposure can be seen at the abandoned Glory Quarry in the southeast part of Blackhawk County [N. of Center, Sec. 36, T. 87 N., R. 11 W]. The Glory Quarry was very famous for its stone in the early days

of paving Iowa roads.

Excellent corals, brachiopods and bryozoans may be obtained from dump-piles in a small abandoned quarry in the Rapid and Solon Members of the Cedar Valley Formation about six miles north of Atalissa in Cedar County [NE Corner, Sec. 34, T. 79 N., R. 3 W., Cedar County](see Trip III, Stop 4).

Most of the quarries and other bedrock exposures in the Iowa City area are in the middle and upper, or Rapid and Coralville Members of the Cedar Valley Formation, which is dominated by a coral and stromatoporoid biostrome. The colonial rugose coral Hexagonaria and other colonial and solitary rugose and colonial tabulate corals may be found in this vicinity, as well as stromatoporoids such as Idiostro-  
ma and Stromatopora. Middle River Quarry on U. S. Highway 218 between Iowa City and Cedar Rapids (opposite Killian's) and Curtis Bridge Quarry, also on Highway 218 [NW 1/4, Sec. 22, T. 81 N., R. 7 W., Johnson County] are mostly in the Coralville Member, with some Rapid near the base of the quarry (see Trip III, Stop 1, and Trip IV, Stop 5). River Products Quarry, just north of the Coralville Interchange on Interstate 80 [NW 1/4, Sec. 33, T. 80 N., R. 6 W., Johnson County] displays both the Coralville and Rapid Members.

The Palo Quarry west of Cedar Rapids near Palo, Linn County [NW 1/4, Sec. 31, T. 84 N., R. 8 W., Linn County] is in the Rapid Member; here may be found an abundant fauna of brachiopods, bryozoans, crinoids, corals, some nautiloids and a few trilobite pygidia (tails)(see Trip IV, Stop 4).

The Shell Rock Formation may be seen in the vicinity of Mason City and along the Shell Rock River. Two of its members (the middle, or Rock Grove, and lower, or Mason City) are exposed at a dam on the northwest edge of the town of Nora Springs [near Center, Sec. 7, T. 96 N., R. 18 W., Floyd County] (see Trip V, Stop 1). The rest of the Rock Grove and the Nora (topmost) Member of the Shell Rock can be seen on Rock Grove Road, near Nora Springs [NE 1/4, Sec. 17, T. 96 N., R. 18 W., Floyd County](see Trip V, Stop 2). This area is fenced off, but may be entered with the owner's permission. Stromatoporoids and brachiopods are common.

The Lime Creek Formation is world famous among collectors, for from it come particularly well-preserved brachiopods as well as numerous corals, snails and bryozoans. This formation also has three members: the Juniper Hill, Cerro Gordo and Owen Members, in ascending order. The lower two members are found in the clay pit of the Rockford Brick and Tile Company on the western outskirts of Rockford [NE 1/4,

NW 1/4, Sec. 16, T. 95 N., R. 18 W., Floyd County]. About three and a half miles southwest of the Brick and Tile pit is the Bird Hill locality, where the upper part of the Cerro Gordo Member and the lowermost foot or two of the Owen Member are exposed. Here also are abundant brachiopods, bryozoans and corals (see Trip V, Steps 3 and 4).

The rest of the Owen Member may be seen in a quarry on the east side of U. S. Highway 65, about nine miles west and slightly more than twelve and a half miles south of Bird Hill. Corals, stromatoporoids and snails are the common fossils. Almost four miles south of this quarry is another small one on the west side of the Highway, also in the Owen Member.

A road cut on the east side of the same Highway 65, about two miles south of the Franklin County line, exposes the uppermost Devonian Sheffield and Aplington Formations. A valley is cut into the shales of the Sheffield Formation; these clay shales are used by a nearby Brick and Tile plant for its raw material. (See Trip V, Stop 6.)

In southeast Iowa, the Maple Mill Shale may be seen in road and stream cuts around Amana, Kalona, English River and in many smaller stream cuts in the area. It is exposed at the

foot of the bluff, just above the railroad at Crapo Park, Burlington. The English River Silstone, which overlies the Maple Mill at this locality, is uppermost Devonian at Crapo Park, and lowermost Mississippian elsewhere in its distribution (see Trip IX, Stop 1).

Mississippian

Devonian

system  
References

MISSISSIPPIAN

General Remarks

The terminology and classification of the rocks assigned to the Mississippian System in Iowa (and in other parts of the country as well) have long been a subject of some controversy. In particular, it has been difficult to determine the boundary between Devonian and Mississippian rocks in Iowa and elsewhere, and, whereas several groups might now claim the matter has been solved, their solutions are not the same.

The problem in large part arises because of the existence of rock units, such as the Maple Mill Shale (see above, DEVONIAN) which have few or no macroscopic fossils (those recognizable without a microscope) and which appear to contain or border the crucial Devonian-Mississippian boundary.

Boundary problems arise over the subdivisions within systems as well as those between systems. However, boundaries between systems are particularly controversial because minor differences in age assignment of a particular rock unit may involve definition of a major portion of geologic time. In a similar fashion, an

uncertainty of a few minutes as to the exact time of day may be nothing more than a mild nuisance, unless it causes you to miss a train. The same uncertainty on the boundary between two days might give rise to legal involvements concerning birth dates, contracts, and the like. If this same few minutes at midnight were on the last day of December -- or, as the case may be, the first day of January -- the complications and controversy would be that much the greater. In the latter case, the few minutes assume major significance because they relate to our definition of a major calendar unit.

Mississippian rocks in Iowa are exposed at the surface in a northwest-southeast trending band, roughly parallel to and southwest of the belt of Devonian rocks. The Mississippian rocks of North America have generally been divided into four major subgroups or Series, rather than the traditional Upper, Middle and Lower. Of these, the uppermost (Chester) is thought to be absent in Iowa. The middle two are more widespread in southeastern Iowa than in the central and north-central parts of the state. This is particularly true of the Osage (lower middle) Series; the Meramec (upper middle) Series has somewhat greater exposure in the north-central area than does the Osage Series. The Kinder-

hook (lowermost) Series is the one over which most of the controversy takes place, and some of the large Kinderhook outcrop area shown on the geologic map of Iowa may well include rocks of Devonian age.

These rocks, except for those of the Kinderhook Series, are dominantly limestones; however, they include varying amounts of shale, especially in the upper part of the Osage Series. Much of the limestone has been altered to dolomite, sometimes rather irregularly. The lowermost Mississippian rocks, including those of disputed age, comprise shales, siltstones and limestones. Many of the limestones of the Osage Series, particularly the Burlington Limestone, consist largely of broken pieces of crinoids. The mineral glauconite is present in some of these formations (for instance, the Burlington Limestone, whose uppermost member, the Cedar Fork, contains enough glauconite in certain layers to give it a distinctly greenish appearance). Most of the limestones have cherty zones or layers at one or more horizons. Some of the limestones and dolomites are oolitic -- that is, they are composed of small, round particles that resemble fish eggs or tapioca. The St. Louis Limestone of the Meramec Series is rather sandy, and the Ste. Genevieve Limestone contains



some shale.

The famous Mississippian geodes of Iowa are found mostly in the lower part of the shaly Warsaw Formation and the upper part of the Keokuk Limestone. They are consistently associated with the argillaceous (muddy) and dolomitic rocks and not with nearby organic fragmental rocks such as those of the Burlington and lower Keokuk limestones. They are thought to have formed from calcareous (limy) concretions by a complex process of replacement, solution and precipitation. These concretions probably were precipitated around some organic nucleus -- a dead animal or plant -- and grew outwards from the center. This growth took place within the limy muds of the sea floor where the organism was buried. Later replacement by silica ( $SiO_2$ ) in the outer part of the concretion produced the tough, knobby, resistant outer coating that distinguishes geodes from vugs and other crystal-lined cavities. Solution of calcite in the center of the concretion provided a cavity. Subsequently, crystals grew in the cavity from the outside inward.

A number of different minerals has been found inside geodes, among which quartz, chalcedony and calcite are the most common. Minerals occurring moderately frequently in

geodes include dolomite, ankerite, aragonite, pyrite, marcasite, sphalerite, pyrolusite, selenite, kaolinite, hematite as coatings on other minerals and limonite as coatings and as pseudomorphs after dolomite, pyrite and marcasite. Among the minerals found rarely in geodes are chalcopyrite, sulfur, hematite crystals and crusts of malachite.

It is believed that the Mississippian rocks were deposited in warm, shallow seas, which fluctuated somewhat in geographic extent during the Mississippian. The sea probably withdrew briefly between Kinderhook and Osage time, and again between Osage and Meramec time. The absence of rocks of the Chester Series probably indicates that Iowa was a land area during the lattermost part of the Mississippian Period.

The rocks exposed in the bluffs along the Mississippi River in Iowa, Illinois and Missouri from Burlington and Keokuk southward to St. Louis form a classic section. This is the type area for the Mississippian System of North America; the system is named for the river.

### Life of the Mississippian

The Mississippian, called in some texts the "Age of Crinoids", was characterized by abundant echinoderms; not only crinoids, but blastoids, starfish and echinoids flourished in those areas where there were warm, shallow seas. Brachiopods continued to be common, and some of the largest brachiopods known come from Mississippian rocks. Clams and snails were abundant, as were cephalopods. The ammonoid cephalopods in particular underwent an expansion and diversification during the Mississippian, but apparently preferred environments slightly different to those in Iowa, for they are very rare in the state. Corals continued to flourish, and both colonial and solitary forms may be found in Iowa. Bryozoans were extremely abundant, and are commonly associated with both crinoids and brachiopods. The corkscrew bryozoan, Archimedes, is characteristic of the Mississippian; in Iowa, it is found mainly in the Warsaw Formation of the Osage Series.

Fishes and amphibians underwent continued development in the Mississippian, and fish teeth and other fish remains may be found in several formations in Iowa; they are particularly abundant in a zone near the top of the Burlington Limestone. The amphibians, however, being land dwellers, are found only in those parts of the country where land deposits were being formed, a good deal further east and west.

The same is true of plants; large forests existed in many areas during the Mississippian, and formed coal deposits in some parts of the world. Insects and other arthropods developed during the Mississippian (and continued to do so during the Pennsylvanian and Permian Periods), but are rather rare fossils.

#### Area of Outcrop

On the geologic map of Iowa, the outcrop areas of the Kinderhook, Osage and Meramec Series are separately delineated. Taken together, these rocks form an outcrop band parallel to and southwest of the Devonian belt.

Rocks commonly assigned to the Kinderhook Series occur at the surface in parts of the following counties: Kossuth, Hancock, Cerro Gordo, Pocahontas, Humboldt, Wright, Franklin, a small part of Butler, Hamilton, Hardin, Grundy, Marshall, Tama, Poweshiek, Iowa, Johnson, Washington, Muscatine, Louisa, Henry, Des Moines and Lee. Parts of those rocks mapped as Kinderhook may, in fact, be of Devonian age.

Rocks of the Osage Series are found in: Humboldt, Webster, a very thin strip along the western border of Hamilton, a small patch in Hardin, Story, Marshall, Grundy, Jasper,

Poweshiek, Iowa, a very small patch in the southwestern corner of Johnson, Keokuk, Washington, Louisa, Jefferson, Henry, Des Moines, Van Buren and Lee counties.

Rocks of the Meramec Series underlie portions of: Humboldt, Wright, Webster, Hamilton, a very small part of Butler, Story, Marshall, small portions of Jasper and Poweshiek, Marion, Mahaska, Keokuk, Washington, a very small corner of Monroe, Wapello, Jefferson, Henry, Des Moines, a very small corner of Davis, Van Buren and Lee counties.

#### Localities

The Kinderhook rocks of Iowa may be seen in quarries and stream valleys throughout the area of outcrop. In southeastern Iowa, the bluffs along the Mississippi River at Burlington provide excellent natural exposures. These can be seen readily at Crapo Park in Burlington (see Trip IX, Step 1), although collecting is not permitted in the park proper. The English River Siltstone may be traced along the foot of the bluff northward along Bluff Road and U. S. Highway 99. Fossils occur in the upper few feet of the formation. The overlying formations may also be traced to either side of the park. The soft green shales of the Maple Mill Shale may generally be seen underlying the English River

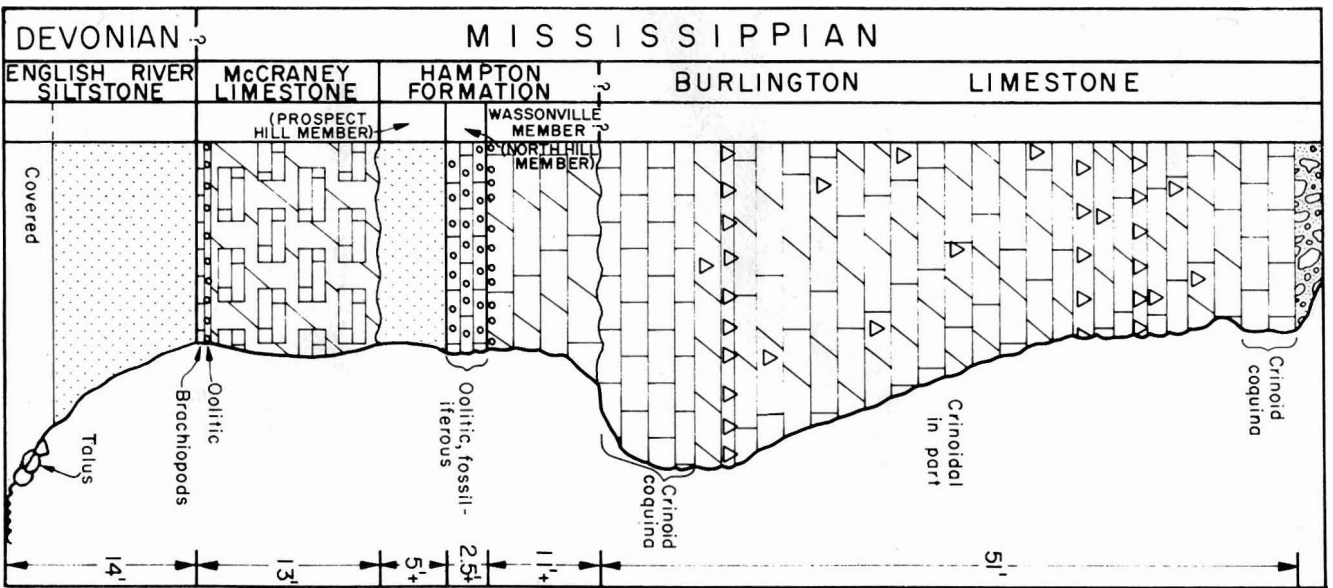


Fig. 5. Section at Starr's Cave

at these exposures.

Essentially the same section may be seen at Starr's Cave on the H. M. Dunn farm [Center of NW 1/4, Sec. 19, T. 70 N., R. 2 W., Des Moines County]. This is one of the early sections described by James Hall in the middle 1800's.

Permission should be secured from the owner (address: R.F.D. Burlington) before visiting.

The English River Siltstone may be seen at its type locality along the English River near Kalona in Washington County. There it is definitely of Mississippian age, whereas it is Devonian at Burlington (see Trip IX, Stop 1).

A number of quarries in the Wellman-West Chester-Keota area expose rocks of Kinderhook and Osage age, from the English River Siltstone to the Burlington Limestone. Gastropods, crinoids and brachiopods such as Chonetes may be collected in the weathered cherts of the Wassonville Member of the Hampton Formation in an abandoned quarry north of Wellman [SW 1/4, Sec. 7, T. 77 N., R. 8 W., Washington County](see Trip VIII, Stop 1). More brachiopods are available at the West Chester quarry of the Kaser Construction Company.

One of the best-known of all Kinderhook exposures in Iowa is that in the famous quarries at LeGrand. The section extends

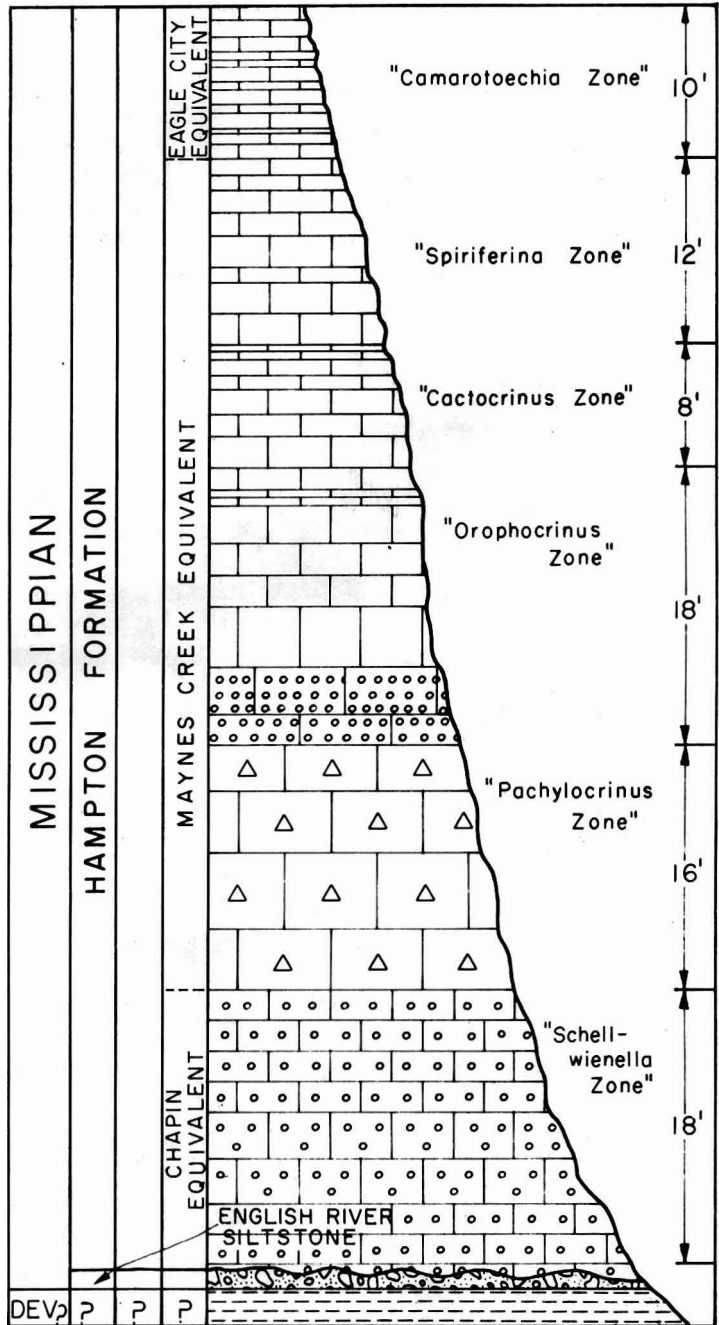


Fig. 6. Section at LeGrand



from a shale, probably of Devonian age, at the base, through the English River Siltstone and a series of beds which are correlated with the various members of the Hampton Formation in both north-central and southeastern Iowa. It was from these zones that the beautiful "LeGrand Crinoids" were taken. The crinoids occurred in "nests" or "colonies", and are very rare between such groupings. Occasional crinoids, as well as a few blastoids, may still be found with diligent searching. Many brachiopods can still be collected in the area, and include such genera as Chonetes, Schellwienella, Rhipidomella, Camarotoechia and Spirifer. The snail Straparollus occurs in the upper part of the LeGrand section, and the blastoid Orophocrinus about in the middle of the section (see Fig. 6).

Waderhook rocks of north-central Iowa include the various members of the Hampton Formation and the Gilmore City Formation. These units may be seen in their type localities near the towns for which they were named. The Chapin Member of the Hampton Formation has its type section in two quarries a little over a mile west of Chapin, Franklin County [SW 1/4, SW 1/4, Sec. 29, and NE 1/4, NE 1/4, Sec. 31, T. 93 N., R. 20 W., Franklin County]. The Maynes Creek Member overlies the Chapin there (see Trip VI, Stop 2).

The Maynes Creek Member has its type locality on Maynes Creek, west of U. S. Highway 65 south of Hampton, Franklin County. The type section is now overgrown, but many quarries in the vicinity, especially around Geneva, Franklin County expose the member (see Trip VI, Stops 2 and 3), which is correlated with the Wassonville Member of southeastern Iowa. A number of spiriferid and productid brachiopods, including Chonetes multicostata, are present in the unit.

The Eagle City and Iowa Falls Members of the Hampton Formation were named for exposures at the respective cities. Neither member is abundantly fossiliferous; careful stratigraphic work indicates that these two units are in part lateral equivalents. They are well exposed at the Weiden Brothers Quarry in the southeastern part of Iowa Falls. To reach the quarry, leave Iowa Falls on U. S. Highway 65 south, and turn east just beyond the railroad underpass. The road goes first through a golf course, and then into the quarry [NW 1/4, NE 1/4, Sec. 19, T. 89 N., R. 20 W., Hardin County].

The Gilmore City Formation may be seen in quarries at Alden such as Wever Construction Company Quarry [SW 1/4, Sec. 17, T. 89 N., R. 21 W., Hardin County] and the Iowa Limestone

Company Quarry [SW 1/4, NE 1/4, Sec. 18, T. 89 N., R. 21 W., Hardin County](see Trip VI, Stop 4). Although a few corals and crinoid stems may be found in these quarries, the formation is much less fossiliferous at Alden than in the type area at Gilmore City. The Midwest Limestone Company quarries northwest of Gilmore City, Pocahontas County [SW 1/4, Sec. 25, T. 92 N., R. 31 W., Pocahontas County] display a more fossiliferous aspect of the formation (see Trip VII, Stop 1).

Formations of Osage and Meramec age are displayed in many roadcuts and quarries in southeastern Iowa. A large number of quarries in the vicinity of Burlington are in the formation of that name. The Burlington Limestone is particularly well-known for its crinoids such as Batocrinus and Dizygocrinus, and the large brachiopod Spirifer grimesi. A zone of fish teeth marks the contact of the Burlington with the overlying Keokuk Limestone. The Leonhard Quarry near Pleasant Grove [SE 1/4, Sec. 1, T. 71 N., R. 4 W., Des Moines County] displays the entire formation (see Trip IX, Stop 3). The Burlington and the overlying Keokuk Limestone are exposed at Raid Brothers Quarry, near Augusta [SE 1/4, NW 1/4, Sec. 25, T. 69 N., R. 4 W., Lee County](see Trip IX, Stop 7). Large specimens of Spirifer, as well as calcite

and chert, can be collected at a quarry at Keota [Sec. 31, T. 76 N., R. 9 W., Washington County](see Trip VIII, Stop 3).

The Keokuk Limestone and the Warsaw Formation are both displayed at the Lee County Quarry at Sandusky. The Keokuk Limestone is extremely fossiliferous there, and the Warsaw Formation contains a few geodes. (Contact the owner, Mr. R. E. Rein, Sandusky, Iowa, or the Lee County Engineer, Mr. C. E. Hales, Fort Madison, Iowa, for permission to visit this site).

These two units are exposed along a number of road and stream cuts in Henry, Lee and Des Moines counties, among them one near Geode State Park, four miles northwest of Augusta [W. 1/2, NE 1/4, Sec. 8, T. 69 N., R. 4 W., Des Moines County](see Trip IX, Stop 5). Several abandoned or temporarily abandoned quarries in the vicinity also provide good collecting for brachiopods and bryozoans.

The H. G. Beattie Quarry [NW 1/4, NW 1/4, Sec. 26, T. 70 N., R. 6 W., Henry County] exposes the limestones and sandstones of the St. Louis Formation overlain by the fossiliferous Ste. Genevieve Limestone. Brachiopods, bryozoans and corals of the Ste. Genevieve ("Pella") fauna may be collected there (see Trip VII, Stop 3, and Trip VIII, Stops 4 and 5). A thin dark shale layer at the base of a twelve-

foot exposure of light-colored limestone at the top of the quarry carries abundant ostracods.

The typical "Pella fossils" are available in great abundance in a number of abandoned quarries in the vicinity of Oskaloosa and Pella. Most of these exposures include Pennsylvanian beds of the Des Moines Series overlying the Ste. Genevieve. A host of brachiopods, horn corals, crinoid stems and rare cups, bryozoans, blastoids and occasional trilobite pygidia or cephalons, as well as clams and snails weather out of the more shaly units of the Ste. Genevieve Limestone. Plant fossils may be secured from the overlying Pennsylvanian sandstones, shales and coal. The Ste. Genevieve becomes more shaly to the northwest, but carries essentially the same rich fauna in the vicinity of Fort Didge, where it may be found along a number of creeks, including Lizard Creek and Soldier Creek, (see Trip VII, Stop 4).

NOTES ON THE PENNSYLVANIAN

Toward the close of the Mississippian Period, seas withdrew from Iowa, and an interval of erosion followed. A number of stream channels were cut into the emergent post-Meramec land surface by streams flowing in a dominantly southwesterly direction. These channels were later filled with clastic sediments.

In Pennsylvanian time, a broad shelf area in Illinois was covered by shallow seas into which a series of deltas was built. The commercial coal deposits are a part of this series. In Iowa, rocks of the Middle Pennsylvanian Des Moines Series were deposited in the Forest City Basin from somewhat northeast of Des Moines southwestward. Here, too, the Des Moines series contains both marine and non-marine units. In eastern Iowa, however, the materials that filled the channels and spread over the land between them had their source far to the east, and were part of one of the great deltas that spread southwestward over Illinois.

Later erosion removed most of the materials from the western margin of this ancient delta. However, in eastern Iowa some erosional remnants, protected in the channels where they were trapped, still exist, lying unconformably on rocks of ages varying from Silurian to Mississippian.

One such channel deposit is located at Wyoming Hill, two miles west of Fairport on State Highway 22, north of Muscatine. The rock units here can be traced across the Mississippi River into the main body of the ancient delta in Illinois. A unit between 62 and 69 feet above the level of the railroad tracks at the foot of the bluff at Wyoming Hill is particularly rich in plant fossils. Another unit between 42 and 45 1/2 feet above the tracks contains abundant root impressions. Frequent slumping brings blocks from these beds down to the level of the railroad where they may be examined more readily.

A similar but much smaller channel is located on the east side of North Dubuque Street 1/2 mile north of the Park Road Bridge on the northern outskirts of Iowa City. Another channel deposit may be seen in Geode State Park along the old road to the beach (see Trip IX, Stop 4).

The high bluffs of cross-bedded sandstone along the Iowa River at Steamboat Rock State Park are also Pennsylvanian. A number of other such outliers are shown on the geologic map of Iowa.

## PLATES

All drawings are about natural size  
unless otherwise specified in the  
Plate Explanations.



## EXPLANATION OF PLATE I

### Fig.

1. Hesperorthis tricenaria, an orthid from the Platteville Formation. a, brachial exterior; b, lateral view; c, posterior view; d, brachial interior.
2. Glyptorthis insculpta, an Upper Ordovician orthid. a, brachial exterior; b, brachial interior; c, pedicle interior; d, lateral view.
3. Glyptorthis bellarugosa, an orthid from the Ion Member of the Decorah Formation; a, brachial exterior; b, pedicle interior. Note that this older species is smaller, more strongly ribbed, and has a simpler pedicle interior than does G. insculpta.
4. Sowerbyella curdsvillensis, X2, a strophomenid from the Decorah Formation. a, brachial exterior; b, brachial interior; c, pedicle interior. Single valves on which internal features may be seen are fairly common in the Ion Shale.
5. Rafinesquina alternata, a strophomenid from the Decorah Formation. a, brachial exterior; b, diagrammatic lateral view as though semi-transparent, to show the curvature of the valves (concavo-convex: brachial valve concave, pedicle valve convex). A closely similar form can be found in the Platteville Formation.

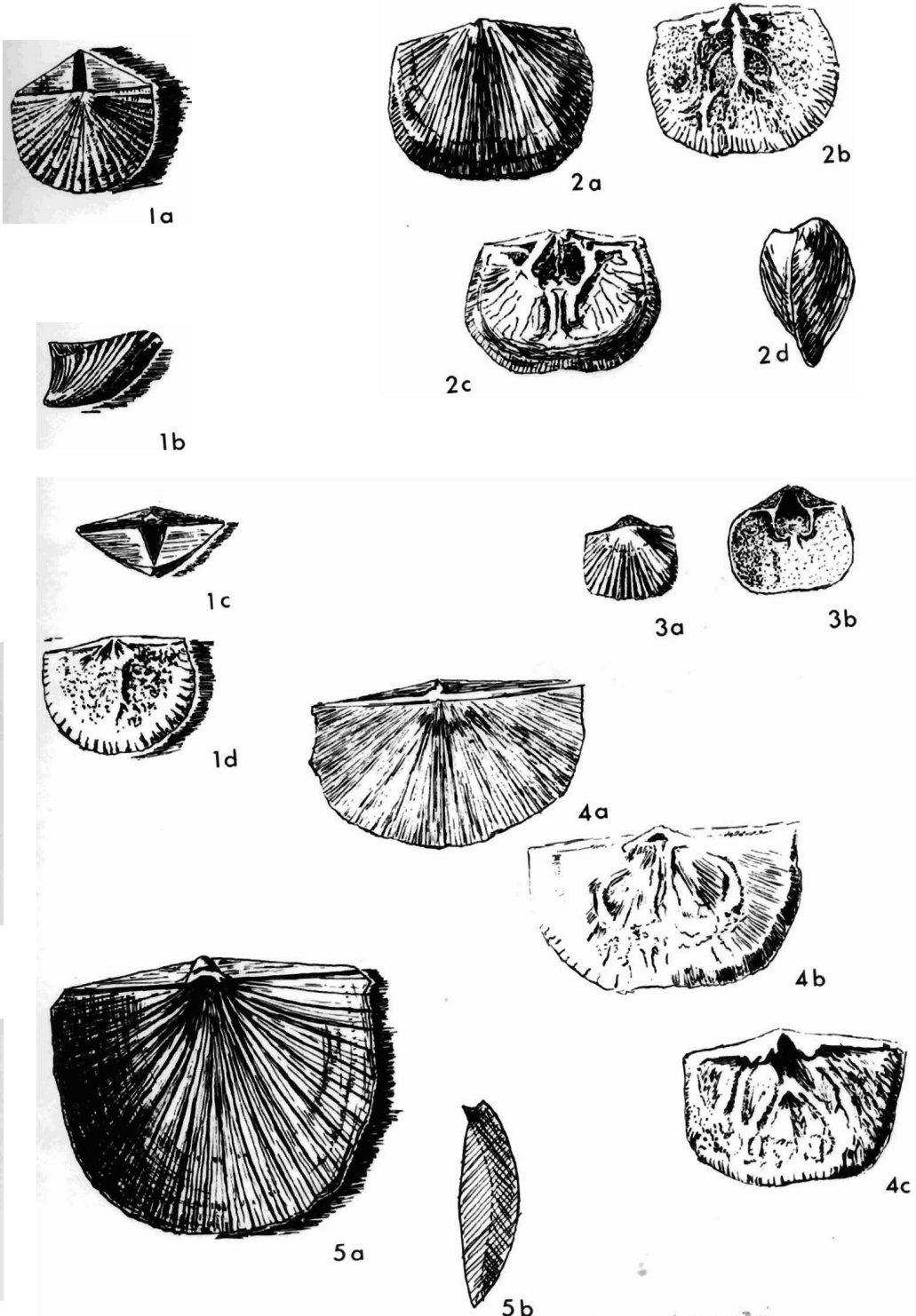


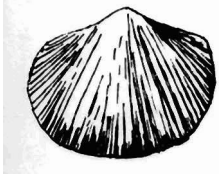
PLATE I. Ordovician Brachiopods

EXPLANATION OF PLATE II

Fig.

1. Doleroides pervetus, an orthid from the Specht's Ferry Member of the Platteville Formation. a, pedicle exterior; b, posterior view; c, lateral view; d, anterior view; e, brachial exterior.
2. Pionodema subaequata, a dalmanellid from the Specht's Ferry Member. a, pedicle exterior; b, posterior view; c, lateral view; d, anterior view; e, brachial exterior.

Two forms which have different biologic classification and yet appear very similar are known as homeomorphs. Doleroides, an orthacean orthid (member of the Order Orthida and the Suborder Orthacea), has an impunctate shell. Pionodema, a dalmanellacean orthid, has a punctate shell. There are also slight differences in shell shape and internal features which permit them to be identified correctly.



2a



1b



2b



1c



2c



1d



2d



1e



2e

PLATE II. Ordovician Brachiopods

## EXPLANATION OF PLATE III

### Fig.

1. Prasopora spp., trepostome bryozoans from the Ion Member of the Decorah Formation. a, side view of an elongate colony; b, an average colony; c, a short colony; d, vertical section through colony (radial lines indicate individual zoecial tubes); e, view of colony from below.
2. Sinuities cancellatus, a planispirally coiled snail from the McGregor Member of the Platteville Formation. a, anterior side; b, apertural side.
3. Endoceras sp., X 1/4, a large nautiloid cephalopod; note the large siphuncle.
4. Isorthoceras sociale, a nautiloid cephalopod abundant in the lower part of the Maquoketa Formation at certain localities. a, portion of internal mold of shell; b, bottom view of a single septum, showing small central siphuncle; c, oblique view of a single septum showing simple "saucer" shape.
5. Ctenodonta sp., external mold of a pelecypod from the Guttenberg Member of the Decorah Formation.
6. Phragmolites fimbriata, a gastropod (snail) from the McGregor Member of the Platteville Formation. a, anterior side; b, left side. This snail is planispirally coiled.



1a



1b

1d



1c



1e



2a



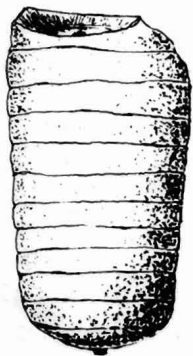
2b



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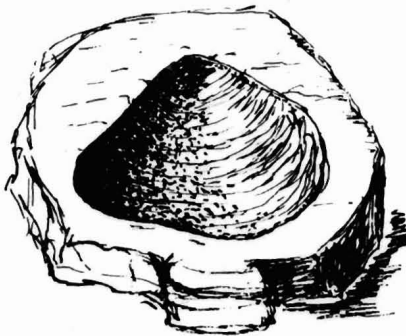
4b



4a



6a



5



6b



4c

## EXPLANATION OF PLATE IV

### Fig.

1. Diplograptus (Glyptograptus) peosta, a graptolite from the lower beds of the Maquoketa Formation; a, crushed and carbonized specimen; b, partly flattened specimen; c, three-dimensional preservation.
2. Cornulites sp., X3 approx., from the Brainard (uppermost) Member of the Maquoketa Formation. This organism, which is similar to Tentaculites (Pl. XI), is of uncertain biological relationships; it is possibly some sort of annelid worm.
3. Receptaculites sp., the "sunflower coral" from the Prosser and Stewartville Members of the Galena Formation. This spongelike organisms appears not to be related to the true corals.
4. Iliaenus americanus, a trilobite from the McGregor Member of the Platteville Formation. a, cephalon (head); b, pygidium (tail).
5. Eoleperditia fabulites, an unusually large ostracod from the McGregor Member of the Platteville Formation. a, left side; b, posterior view. Most ostracods are microscopic, but Eoleperditia is known to reach over half an inch in length.
6. Cheirurus sp., a trilobite from the Platteville and Decorah Formations. a, dorsal view of a complete specimen; b, hypostoma (plate from underside of body).
7. Isotelus gigas, a trilobite from the Maquoketa Formation. a, dorsal view of a complete specimen; b, hypostoma. Other species of Isotelus are found in the Platteville Formation.
8. Ceraurus pleurexanthemus, a trilobite from the McGregor Member of the Platteville Formation; dorsal view of a complete specimen.

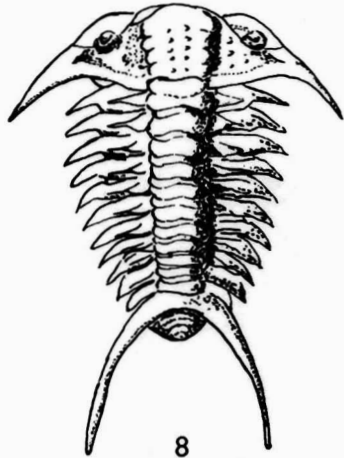
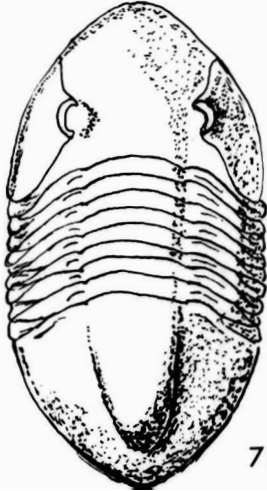
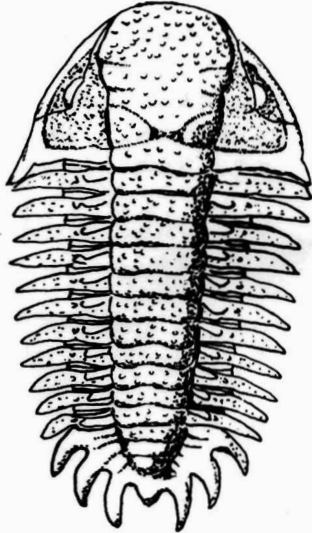
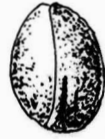
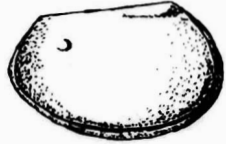
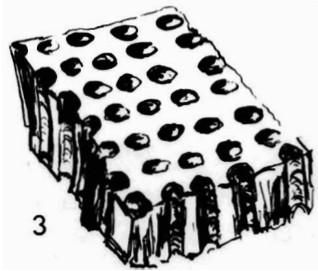
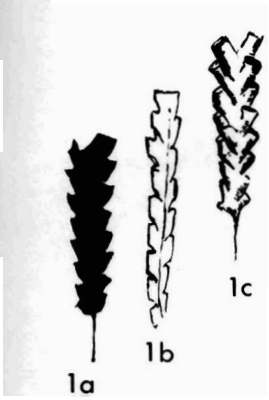


PLATE IV. Ordovician Arthropods, Graptolites and Miscellaneous



## EXPLANATION OF PLATE V

### Fig.

1. Leptaena "rhomboidalis", a strophomenid from the Hopkinton Formation. a, brachial exterior; b, pedicle interior; c, pedicle exterior. This is a "form species" used as a catch-all for a number of similar Silurian and Devonian forms.
2. Platyerella manniensis, X3, a pentamerid from the Kankakee Formation. a, pedicle exterior; b, brachial exterior. A fold is commonly present on the pedicle valve, and a sulcus on the brachial valve among the pentamerids, a reversal of the usual condition in brachiopods.
3. Pentamerus "laevis", internal mold of a typical pentamerid, common in the Hopkinton Formation, showing the impression of several plates and other features of the inside of the brachial valve. This species and P. oblongus (see below) are now thought to be the same.
4. Pentamerus oblongus, internal mold of a large specimen from the Hopkinton Formation.
5. Stricklandia castellana, a pentamerid found in a number of Silurian formations. a, brachial exterior; b, pedicle exterior.

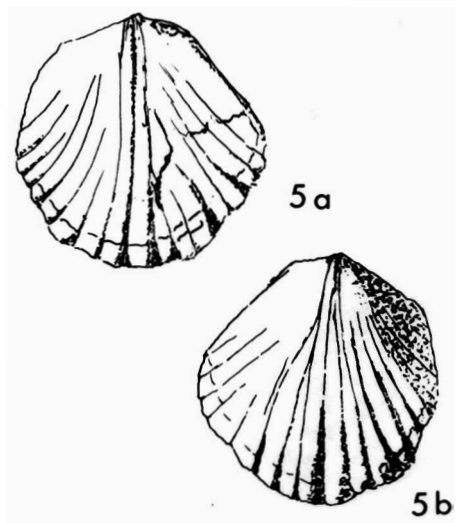
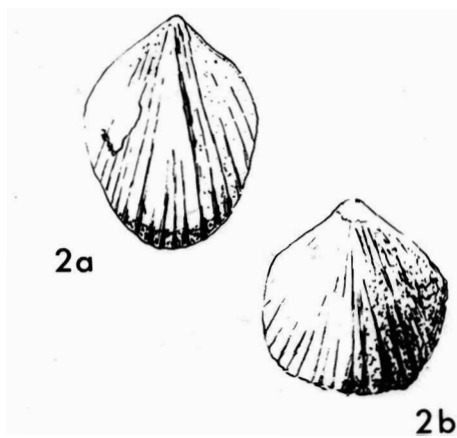
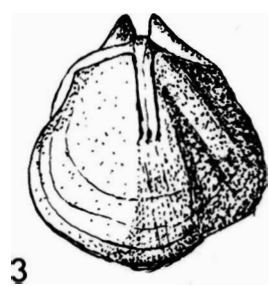
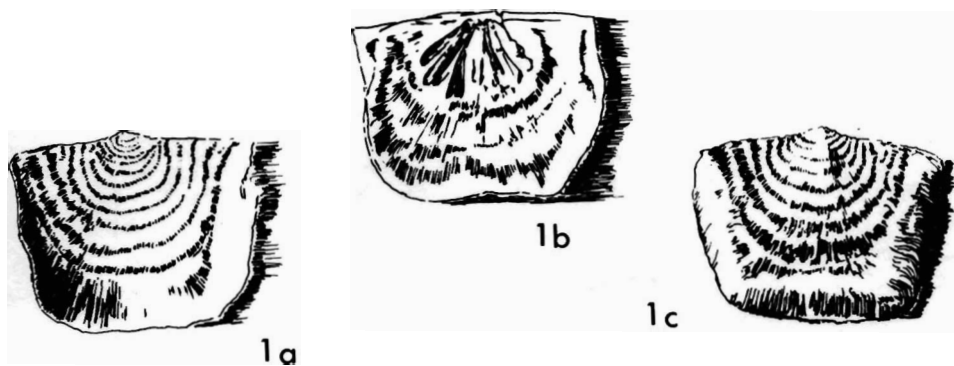


PLATE V. Silurian Brachiopods

## EXPLANATION OF PLATE VI

### Fig.

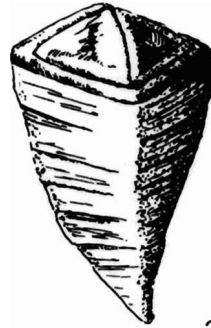
1. Halysites spp., a colonial tabulate from the Hopkinton Formation. a, portion of a colony with two natural longitudinal sections (indicated by arrows) showing the tabulae; b, diagrammatic top view of the colony, enlarged; c, portion of another colony showing slightly different growth pattern.
2. Goniophyllum pyramidale, a solitary rugose coral from the Hopkinton Formation. This unusual "square coral" is found only in restricted areas of Silurian rock in Iowa and in Europe. Note operculum or cover over calyx.
3. Favosites spp., a colonial tabulate coral from the Hopkinton Formation. a, entire small colony, somewhat reduced; b, portion of colony showing mode of growth; c, d, natural section and diagrammatic sketch (enlarged) to show the tabulae and mural pores. Other species of Favosites are common in Devonian rocks as well.
4. Heliolites sp., X5 approx, portion of a colony of this tabulate coral from the Hopkinton Formation.
5. Syringopora sp., a tabulate, loosely connected colonial coral from the Hopkinton Formation. A natural longitudinal section at the left end shows the deeply sagging tabulae.



1a



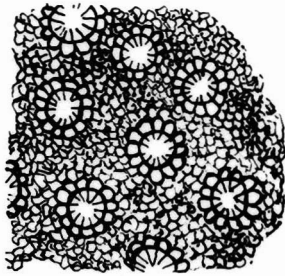
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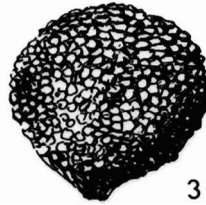
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1c



4



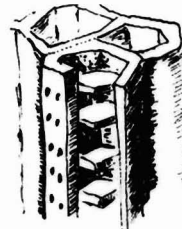
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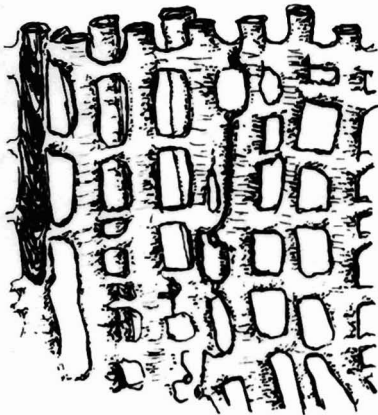
3b



3c



3d



5

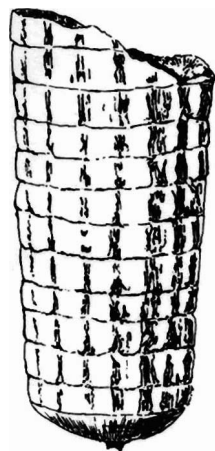
PLATE VI. Silurian Corals

## EXPLANATION OF PLATE VII

### Fig.



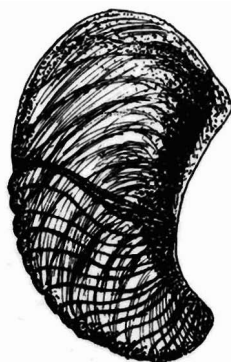
1. Kionoceras sp., X 2/3 approx., a nautiloid cephalopod found in the Hopkinton Formation. Note the small siphuncle and the longitudinal ribbing.
2. Phragmoceras spp., curved nautiloid cephalopods known from a number of Silurian formations, among them the Hopkinton Formation. a, lateral view; b, apertural view showing modification of the aperture.
3. Metarizoceras sp., a nautiloid (oncocerid) cephalopod from the Gower Formation. a, lateral view (ventral side is to the left); b, ventral view.



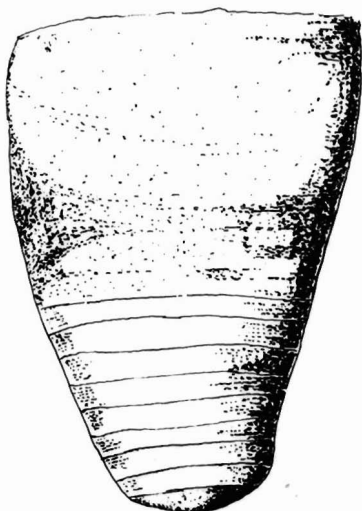
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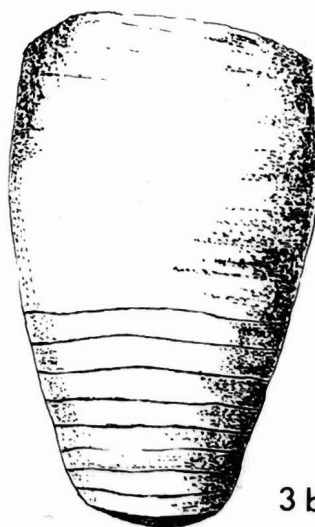
2b



2a



3a



3b

PLATE VII. Silurian Cephalopods

## EXPLANATION OF PLATE VIII

### Fig.

1. Clathropora frondosa, a cryptostome bryozoan from the Hopkinton Formation. A nearly complete colony.
2. Eucalyptocrinites crassus, a crinoid from the Gower Formation. a, nearly complete specimen showing arms, calyx (cup) and part of the stem; b, calyx or cup.
3. Pisocrinus quinquelobus, a very small crinoid from the Hopkinton Formation. a, crown (cup and arms); b, cup.
4. Calymene niagarensis, a trilobite from the Hopkinton Formation. a, lateral view of a complete specimen; b, dorsal view of the same. Note the "sway-backed" effect in the lateral view; this is characteristic of Iowa forms.
5. Petalocrinus mirabilis, an unusual crinoid from the Hopkinton Formation. a, single "petal-arm", natural size (these are all that is generally found); b, reconstruction of the entire animal, X2 approx.

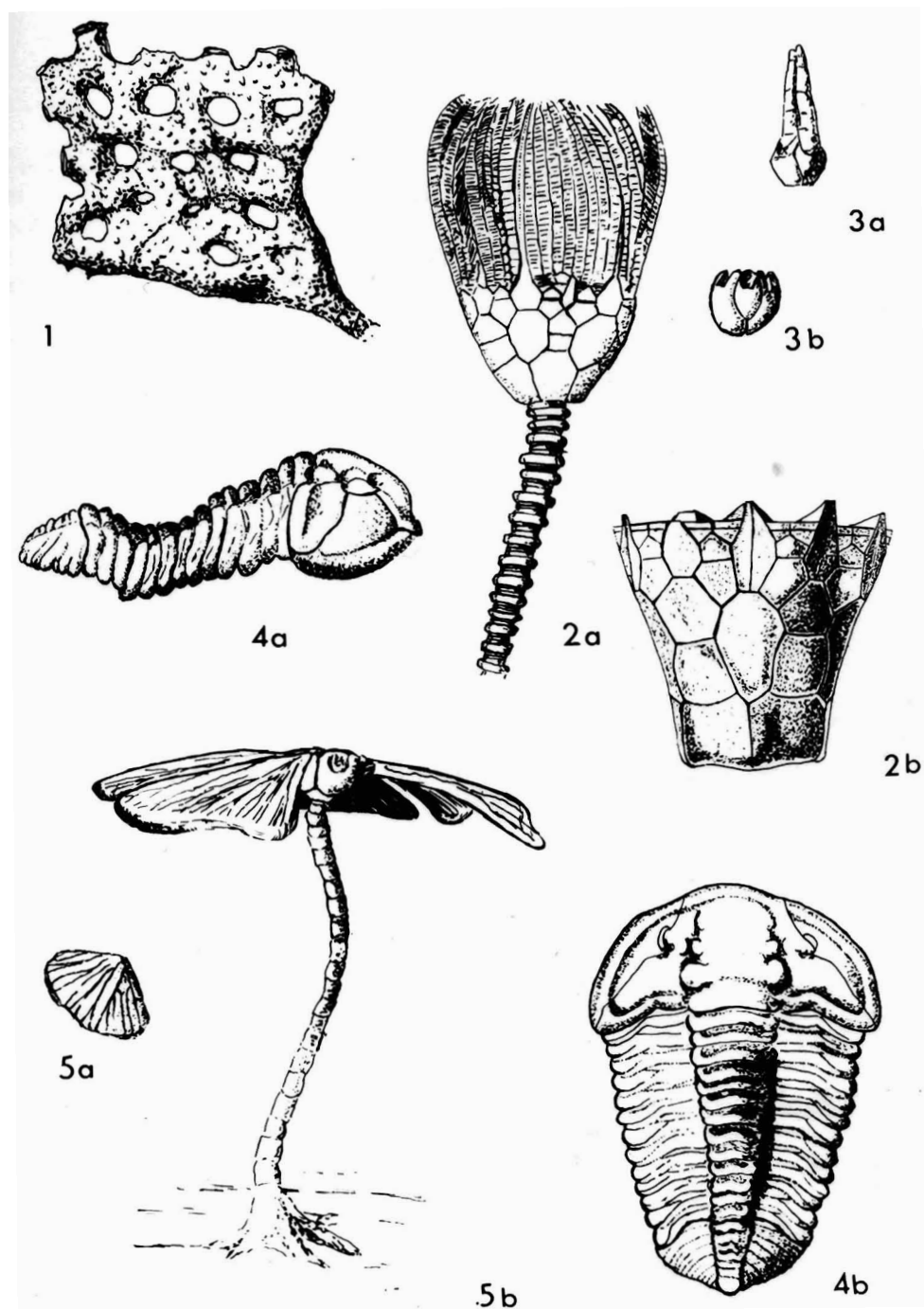


PLATE VIII. Silurian Echinoderms, Trilobites and Bryozoa.



## EXPLANATION OF PLATE IX

### Fig.

1. Platyrachella iowensis, a spiriferid from the Solon Member of the Cedar Valley Limestone. Brachial view of a large specimen with unbroken "wings" extending from the hinge line. Note lack of costae (radial ribs) on the fold (same is true on the sulcus on the pedicle valve, not shown). The genus Mucrospirifer closely resembles Platyrachella, but has costae on the fold and sulcus.
2. Atrypa bellula, an atrypacean spiriferid. This somewhat spiny species of Atrypa is characteristic of the base of the Rapid Member of the Cedar Valley Formation; some authors place it in a separate genus, Hystericina.
3. Atrypa independensis, a large Atrypa characteristic of the Solon Member of the Cedar Valley Limestone. a, brachial exterior; b, lateral view.
4. Cranaena iowensis, a terebratulid from the Cedar Valley Formation. a, lateral, and b, brachial views of a specimen from the Rapid Member at Palo, showing radial color bands.
5. Cranaena romingeri, brachial view of a small species; the specimen shown is also from the Rapid Member at Palo, and shows color bands.
6. Camarotoechia contracta, a rhynchonellid from the Aplington Formation (Upper Devonian). a, pedicle exterior; b, brachial exterior; c, anterior view.
7. Cleiothyridina humerosa, a rostrospiracean spiriferid from the Aplington Formation. a, pedicle exterior; b, anterior view; c, brachial exterior.

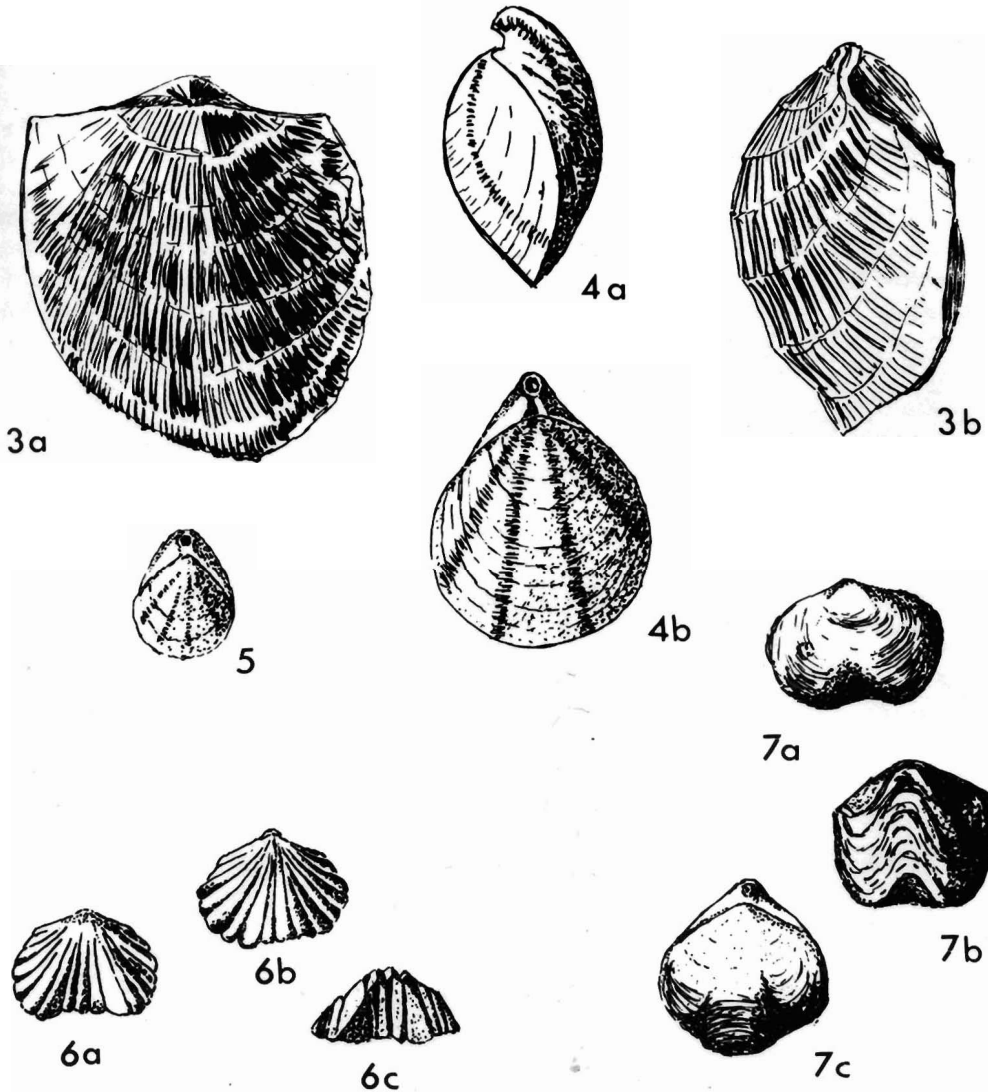
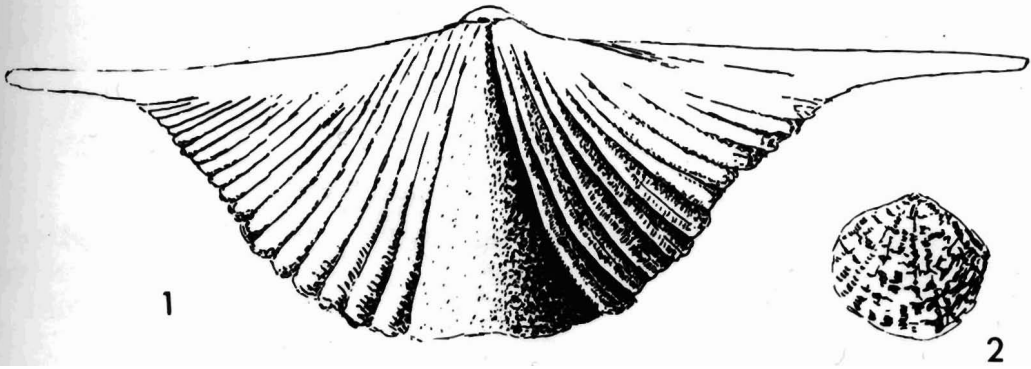


PLATE IX. Devonian Brachiopods

## EXPLANATION OF PLATE X

### Fig.

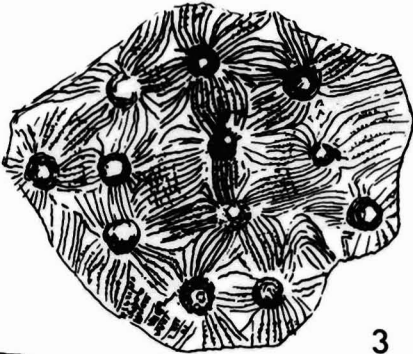
1. Stromatopora sp., a stromatoporoid (hydrozoan coelenterate) common in Devonian rocks. Portion of a colony showing the layered effect and the monticules (nodes on the surface).
2. Hexagonaria spp., a colonial rugose coral found in many Devonian formations in Iowa and elsewhere. a, portion of a colony showing the walls between individuals and the axial pit or depression of each member of the colony; b, sketch of a whole colony, much reduced, showing manner of growth.
3. Billinsastrea sp., another colonial rugose coral, particularly characteristic of the Solon Member of the Cedar Valley Limestone. Portion of a colony; note the axial pit of each individual, and the lack of walls between individuals.
4. Zaphrentis sp., a solitary rugose coral, particularly abundant in the Cedar Valley Limestone; one of the common Devonian "horn corals".
5. Heliophyllum halli, a solitary rugose coral from the Cedar Valley Limestone (other species are found in other Devonian formations in Iowa). a, a short individual; b, an elongate individual; c, diagrammatic enlargement showing "yardarm carinae" on the septa; this feature is characteristic of the genus.
6. "Cystiphyllum" sp., a solitary rugose coral. This "form genus" embraces a number of rugose corals having dissepiments (many small, globose plates) instead of septa and tabulae; it is a common Devonian and Silurian form.



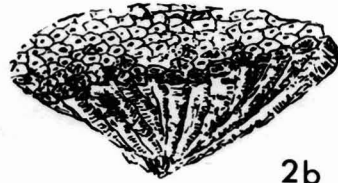
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2a



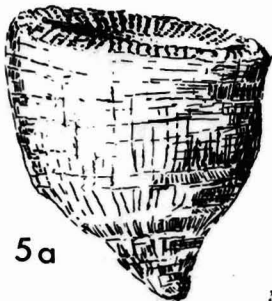
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2b



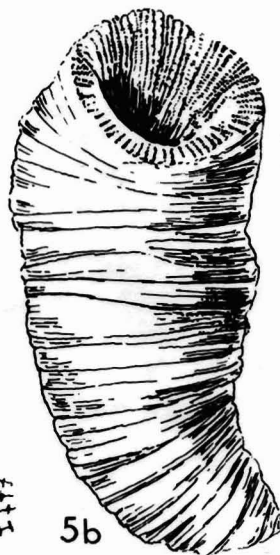
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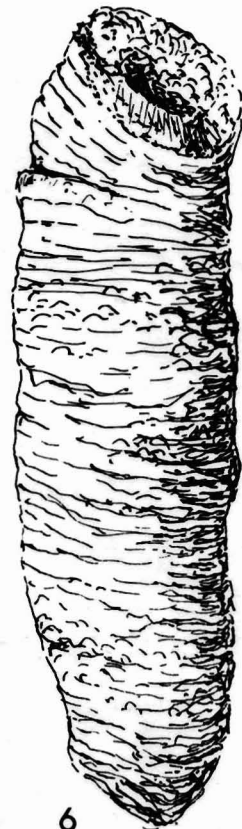
5a



5c



5b



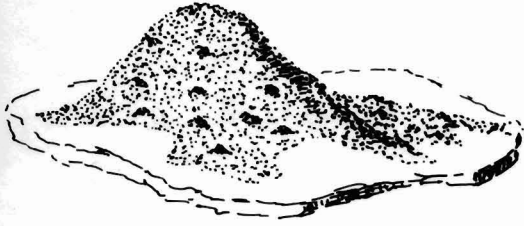
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PLATE X. Devonian Corals

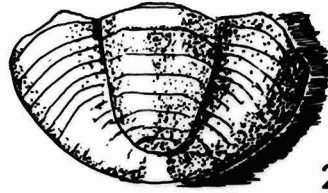
## EXPLANATION OF PLATE XI

### Fig.

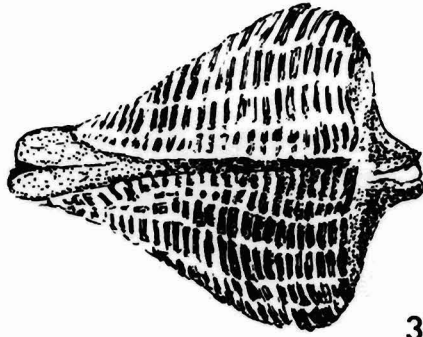
1. Trepastome bryozoan, a low, mound-shaped colony from the Rapid Member of the Cedar Valley Limestone at Atalissa, showing monticules.
2. Proetus sp., X 3 1/2 approx., from the Cedar Valley Formation. Pygidium or tail.
3. Conocardium sp., an oddly-shaped pelecypod with distinctive ornamentation; common in certain zones of the Coralville Member of the Cedar Valley Limestone.
4. Tentaculites sp., an organism of doubtful biological affinities (possibly an annelid) from the Rapid Member of the Cedar Valley Limestone. a, whole large specimen, natural size; b, enlargement of a portion of the individual (about X3) to show ornamentation.
5. Straparollus sp., one of many very similar Paleozoic gastropods (snails). Common in certain zones of the Cedar Valley Limestone and other Devonian and some Mississippian formations in Iowa. Preservation is very rarely as good as that shown here.
- X 6. Strobilocystites sp., a cystoid from the Rapid Member of the Cedar Valley Limestone at Palo. a, side view; b, top view. Notice the distinctive sieve-like, rhomb-shaped areas called pectinirhombs. Plates from these cystoids are abundant in certain zones in the Rapid Member at Palo; whole cups are much rarer.
7. Megistocrinus sp., a crinoid from the Cedar Valley Limestone. Plates and occasional whole cups are found in the Rapid Member at Palo.



1



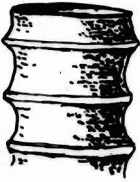
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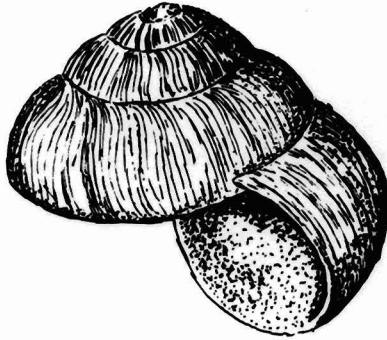
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4a



4b



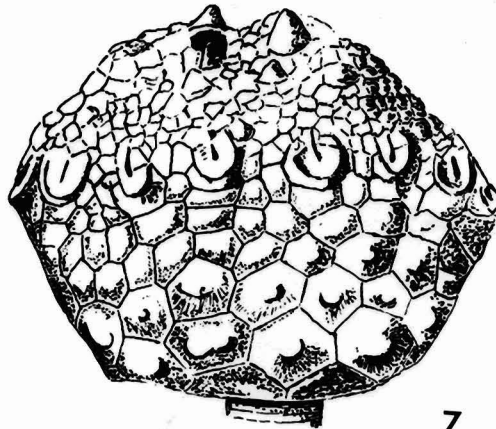
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6a



6b

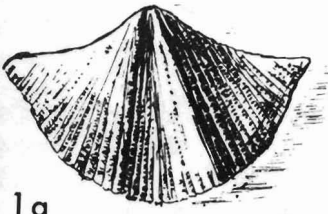


7

## EXPLANATION OF PLATE XII

### Fig.

1. Cyrtospirifer whitneyi, a spiriferid from the Cerro Gordo Member of the Lime Creek Formation. a, pedicle exterior; b, brachial exterior.
2. Lingula fragilis, X2 1/2, an inarticulate brachiopod from the Juniper Hill Member of the Lime Creek Formation.
3. Tenticospirifer cyrtiniformis, X2, a spiriferid from the Cerro Gordo Member. a, pedicle exterior; b, posterior. A comparatively uncommon form.
4. Douvillina sp., a strophomenid from the Cerro Gordo Member. a, pedicle exterior; b, brachial exterior. A small specimen; note the concavo-convex shape.
5. Theodossia hungerfordi, a spiriferid from the Cerro Gordo Member. a, a young individual; b, lateral view; c, brachial exterior. Note the difference in shape between the immature and mature individuals.
6. Schizophoria iowensis, a dalmanellacean orthid from the Cerro Gordo. a, anterior view; b, posterior view; c, pedicle exterior.
7. Platyrachella oweni, a spiriferid from the Cerro Gordo Member. Brachial view; this species does not develop the long "wings" found in P. iowensis (Pl. IX). Note lack of costae (ribs) on fold and sulcus, in contrast with Cyrtospirifer. A rather uncommon form.



1a



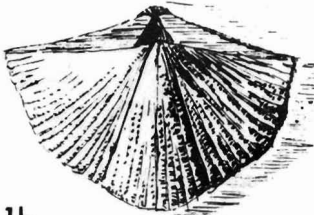
2



3a



3b

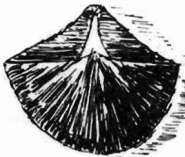


1b



4a

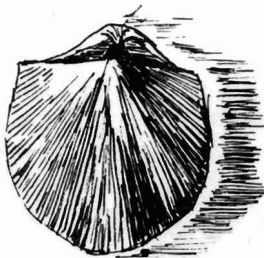
4b



5a



5b



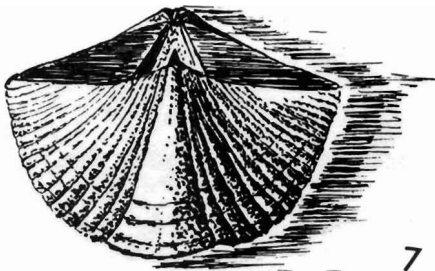
5c



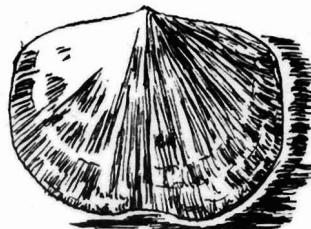
6a



6b



7



6c

PLATE III. Upper Devonian Brachiopods (Lime Creek)



## EXPLANATION OF PLATE XIII

### Fig.

1. Atrypa devoniana, an atrypacean spiriferid brachiopod from the Cerro Gordo Member of the Lime Creek Formation. a, brachial exterior; b, lateral view; c, pedicle exterior. Probably the most abundant brachiopod of the Cerro Gordo Member.
2. Atrypa rockfordensis, the "spiny Atrypa" of the Cerro Gordo. Look for "dirty" specimens, in which the spines are preserved in the muddy matrix.
3. Idiostroma sp., X10 approx., a stromatoporoid from the Owen Member. Oblique section through a branch of the colony. Also occurs in the Cedar Valley Formation.
4. Strophonelloides hybrida, a strophomenid brachiopod from the Cerro Gordo. Pedicle interior; note the large, distinctive muscle scar and serrations along hinge line.
5. Productella walcotti, a small productid brachiopod from the Cerro Gordo. Pedicle view; brachial valve is generally obscured by matrix. Note spines.
6. Pachyphyllum woodmani, a colonial rugose coral from the Cerro Gordo. Portion of a colony; note that the individual calyces have a projecting rim and deep axial pit.
7. Ramose (branching) and encrusting bryozoans from the Cerro Gordo. a, b, two views of the same specimen. Lioclema and Petalotrypa are the commonest genera with this external form, thin sectioning is required to differentiate them. The common, small, pencil lead-like forms belong largely to the genus Orthopora.
8. Westernia pulchra, a high-spined gastropod from the Cerro Gordo.
9. Paracyclas sabini, a small pelecypod from the Cerro Gordo.
10. Holopea (?) iowensis, another conispirally coiled snail.
11. Floydia concentrica, one of the commonest Cerro Gordo snails, but generally found as featureless fragments of internal molds.

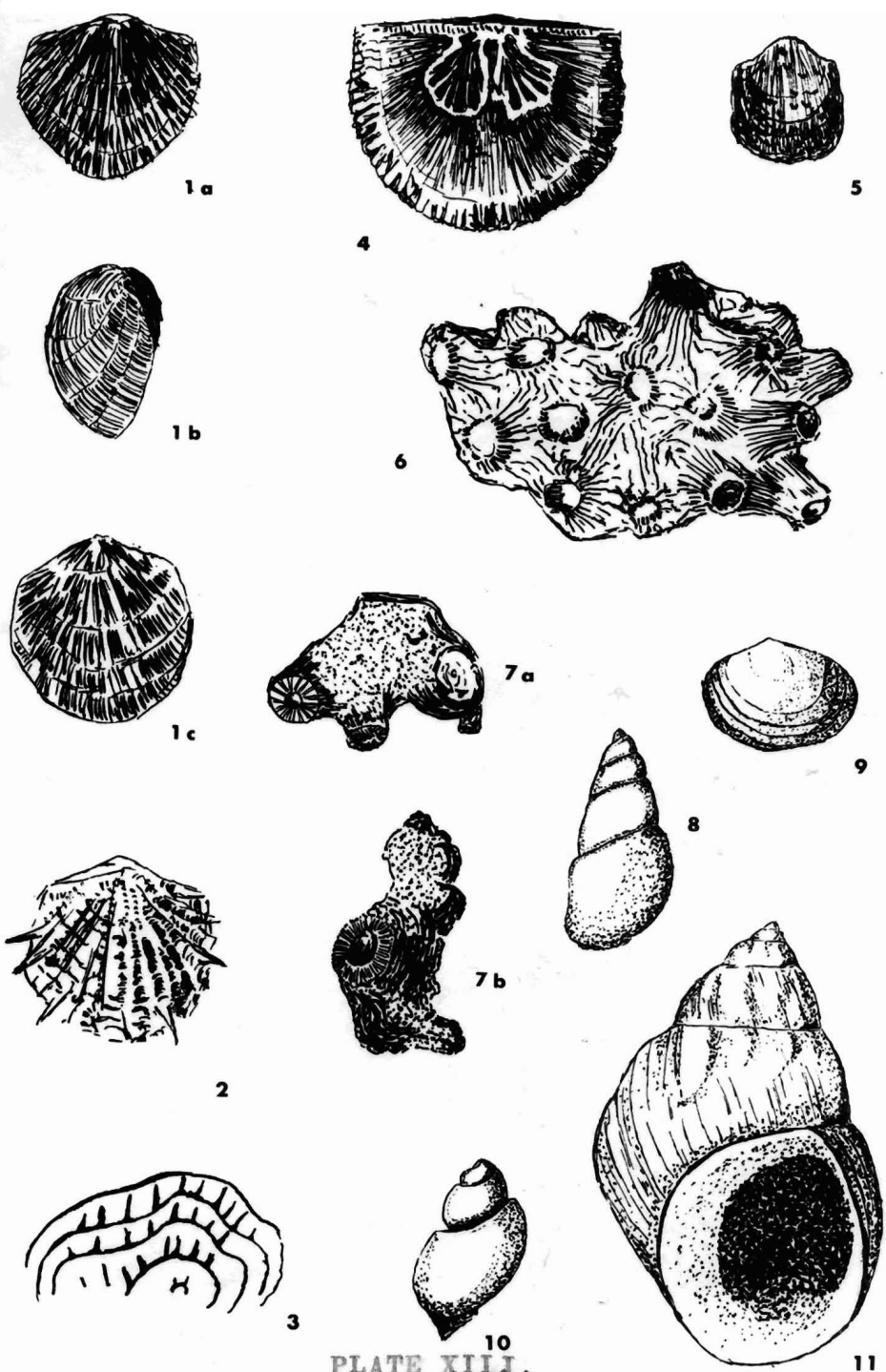


PLATE XIII.

Upper Devonian Brachiopods and Miscellaneous (Lime Creek)

EXPLANATION OF PLATE XIV

Fig.

1. Torynifer pseudolineata, a spiriferid from the Keokuk Limestone. Lateral view showing large pedicle beak. Externally, closely resembles Athyris lamellosa (see below) but has a large, triangular opening for the pedicle in the moderately large interarea.
2. Leptaena analoga, a strophomenid common in the Wassonville Member of the Hampton Formation. a, pedicle interior; b, pedicle exterior. Smaller forms of this species found in the uppermost of the chert layers of the Wassonville Member.
3. Athyris lamellosa, a rostrospiracean spiriferid from the Keokuk Limestone. Pedicle exterior.
4. Spirifer keokuk, a spiriferid, one of the many Mississippian species of this genus. a, anterior view; b, pedicle exterior; c, lateral view.
5. Schellwienella burlingtonensis, X2. Brachial valve showing cardinal processes.
6. Spiriferina sp., X2 approx., pedicle view of a flattened specimen from the Keokuk Limestone.
7. Spirifer grimesi, pedicle exterior. The large Spirifer of the Burlington Limestone.

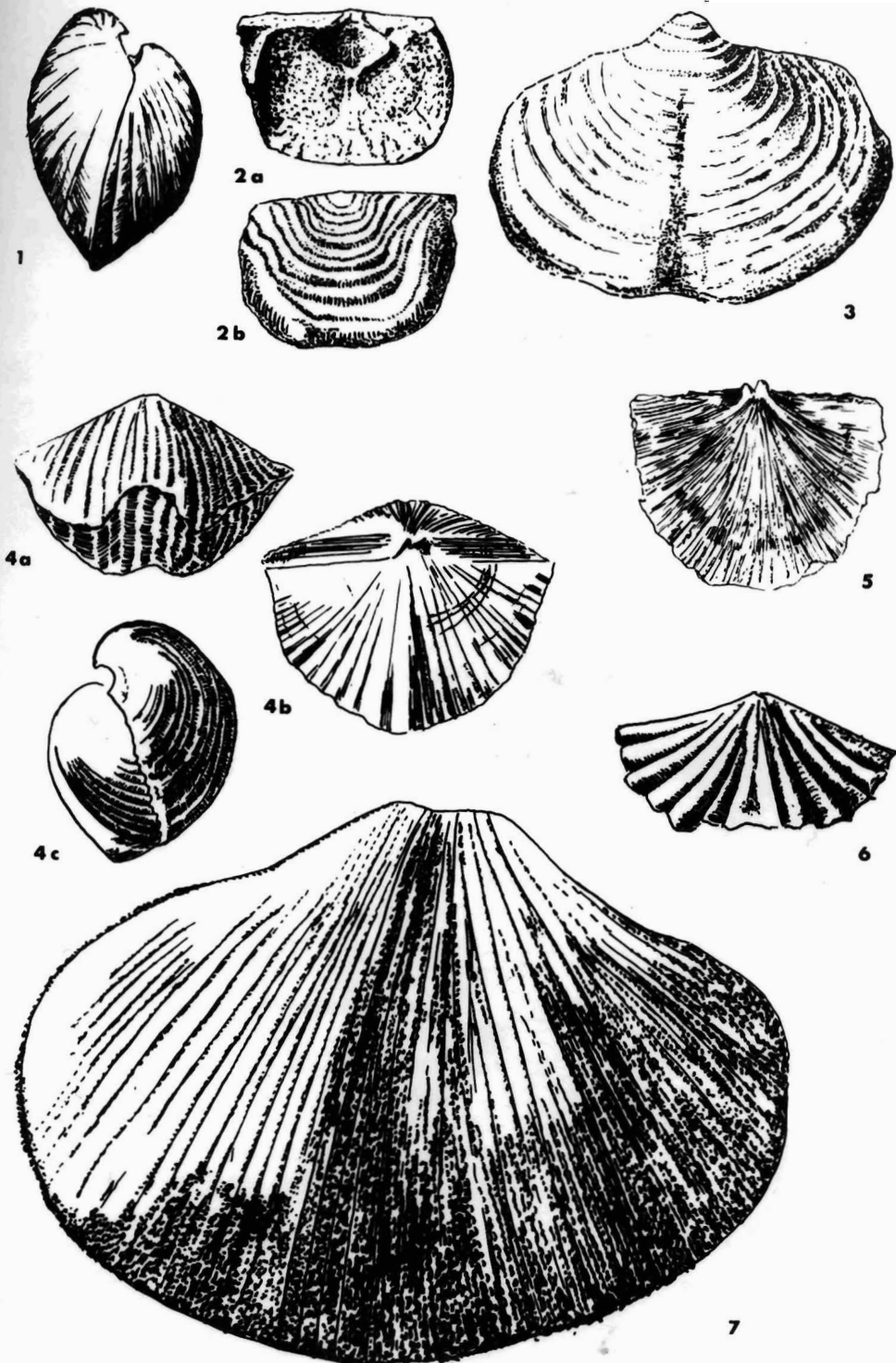


PLATE XIV. Mississippian Brachiopods

## EXPLANATION OF PLATE XV

### Fig.

1. Setigerites setigerus, pedicle exterior of a typical Mississippian productid.
2. Dictyoclostus sp., brachial exterior of another typical large productid.
3. Chonetes spp., a generally small, thin-shelled productid with a row of spines along the hinge-line. a, brachial exterior; b, pedicle exterior; c, pedicle interior; d, pedicle and brachial exteriors of the very small C. logani, found in the Wassonville Dolomite.
4. Chonopectus fischeri, a productid, similar to Chonetes, commonly occurring as external casts in the English River Siltstone.
5. Rhipidomella tenuicostata, a dalmanellacean orthid from the Chapin Member of the Hampton Formation. a, pedicle exterior; b, brachial exterior.
6. Rhipidomella burlingtonensis, pedicle valve of a larger species of the genus Rhipidomella from the Burlington Limestone.
7. Eumetria verneuiliana, a punctospiracean spiriferid from the Gilmore City Formation. This punctospiracean, although belonging to the Order Spiriferida, superficially resembles certain terebratulids.
8. Rhynchopora cooperensis, a rhynchoporacean rhynchonellid from the Gilmore City Formation. These small rhynchonellids are placed in a separate Suborder because their shells are punctate. a, pedicle; b, brachial; c, anterior.
9. Paryphorhynchus striaticostatum, a rhynchonellid from the McCraney Limestone. a, pedicle exterior; b, brachial exterior.

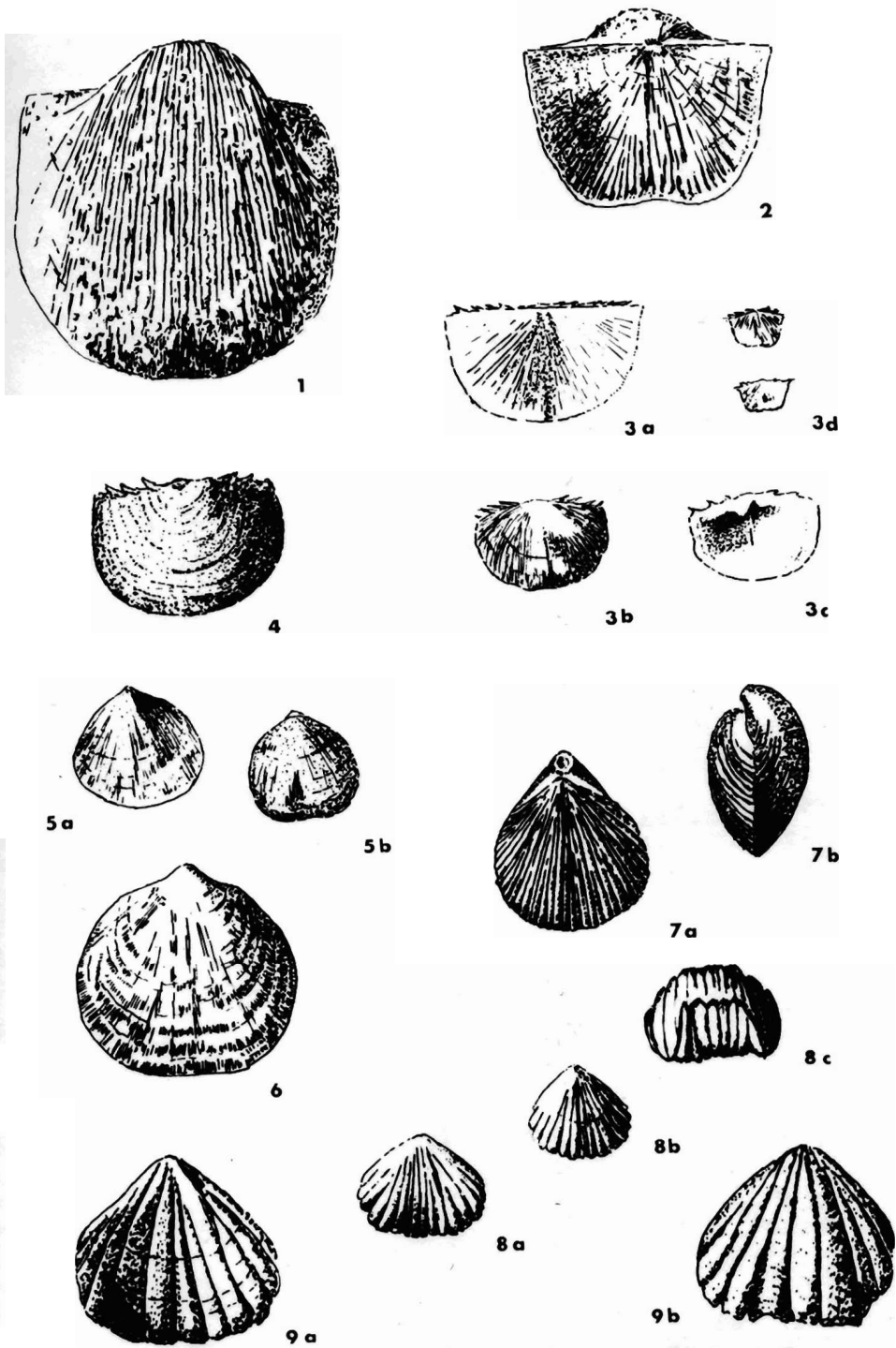
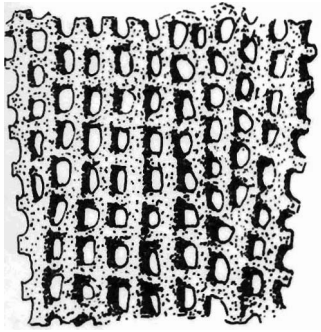


PLATE IV. Mississippiian Brachiopoda

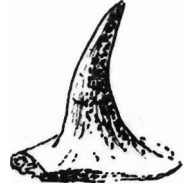
## EXPLANATION OF PLATE XVI

### Fig.

1. Hemitrypa proutana, X9, a typical Mississippian fenestellid bryozoan, common in the Keokuk Limestone. Note the "window" or "lacey" structure.
2. A typical small ramose (branching) bryozoan from the Keokuk Limestone.
3. Fish tooth, from the fish tooth zone at the top of the Burlington Limestone.
4. Cyathaxonia arcuata, a small solitary rugose coral from the Chapin Member of the Hampton Formation. a, lateral view; b, calycal view, showing small axial columella (knob) in the deep calyx.
5. Archimedes sp., a peculiar fenestellid bryozoan in which a corkscrew-shaped axial portion of the colony is developed. a, portion of the entire colony; b, axis only (the axial screw is more readily preserved than the fronds). Known from the Warsaw Formation.
6. Lithostrotionella sp., a colonial rugose coral superficially similar to Hexagonaria; note the axial columella in the center of each calyx.



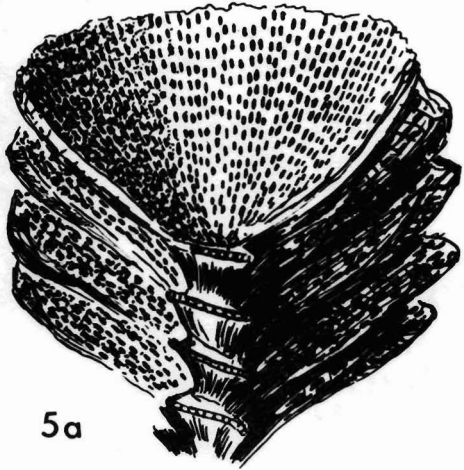
1



3



2



5a



4b



4a



5b



6

PLATE XVI. Mississippian Corals and Bryozoa



## EXPLANATION OF PLATE XVII

### Fig.

1. Platycrinites spp., crinoids from the Burlington Limestone. a, complete specimen showing arms, calyx, and the distinctive twisted stem; b, single solummal (stem-plate); c, calycal plate of P. hemisphericus showing "nodes"; d, cup of the smooth P. burlingtonensis.
2. Orophocrinus conicus, slightly enlarged, a blastoid from the Orophocrinus Zone of the Gilmore City Formation. a, top view; b, side view.
3. Rhodocrinites wortheni, a smooth-plated species from the Gilmore City Formation and the Burlington Limestone. Side view of a specimen with an almost complete crown.
4. Rhodocrinites douglassi, a smaller species of Rhodocrinites with stellate ornament on the calycal plates, from the Rhodocrinites Zone in the Gilmore City Formation. Lateral view.
5. Dichocrinus campto, X2, a very small crinoid from the Gilmore City Formation.
6. Batocrinus subaequalis, a typical camerate crinoid from the Burlington Limestone. Note the row of small holes around the widest circumference; here the arms attached.
7. Dizygocrinus rotundus, a camerate crinoid common in some horizons of the Cedar Fork Member of the Burlington Limestone.
8. Dichocrinus inornatus, a larger species of Dichocrinus found in the Burlington Limestone.
9. Cactocrinus imperator, a large species of the genus with stellate ornamentation on the cup-plates, from the Gilmore City Formation. A smooth-plated form, C. glans, is found in the Burlington Limestone.

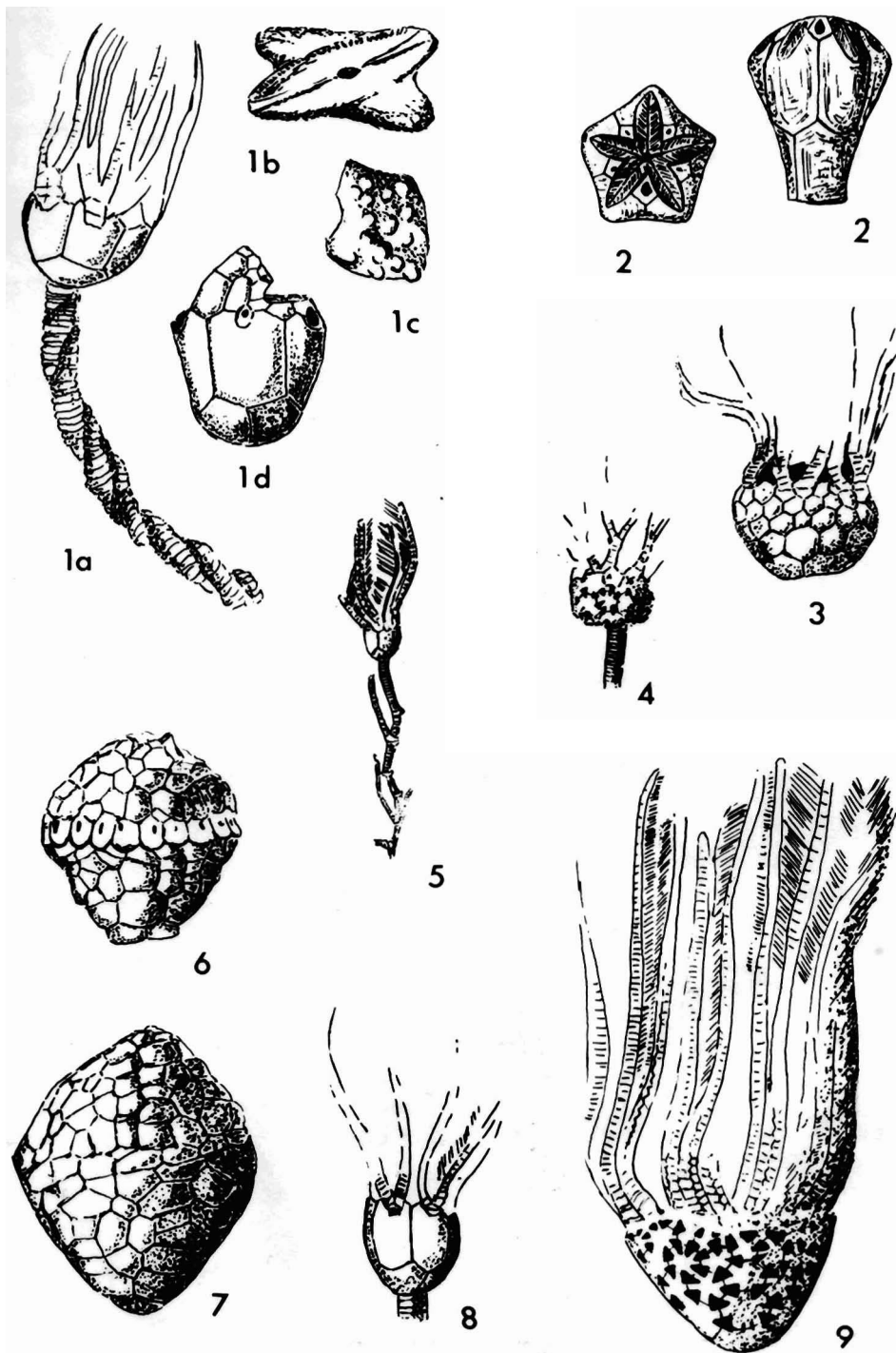


PLATE XVII. Mississippian Echinoderms

## EXPLANATION OF PLATE XVIII

Fig.

1. Pentremites conoidea, a small blastoid. a, side view; b, view from below.
2. Bryozoan colony growing on crinoid stems. a, early stage of encrustment; b, late stage of the colony's growth; the stem is completely hidden except where the colony is broken.
3. Allorisma sp., exterior of left valve of this pelecypod.
4. Girtyella indianensis, a small terebratulid brachiopod. a, lateral view; b, brachial exterior; c, pedicle exterior.
5. "Zaphrentis" pellaensis, a solitary rugose coral. a, lateral view; b, diagrammatic view of calyx. This spiny horn coral was long ago placed in a genus now restricted to Devonian forms, but the species has not yet been placed in a new genus.
6. Phillipsia sp., a trilobite; this specimen is flexed and somewhat distorted.
7. Pugnoides ottumwa, a rhynchonellid brachiopod. a, b, pedicle and brachial exteriors of a wide specimen; c, d, pedicle and brachial exteriors of a narrow specimen.
8. Spirifer pellaensis, a spiriferid brachiopod. a, brachial exterior of a short specimen without "wings"; b, posterior view of a wide, "winged" specimen; c, pedicle exterior of a wide specimen.
2. Composita trinuclea, a rostrospiracean spiriferid brachiopod. a, pedicle exterior; b, brachial exterior; c, anterior view.

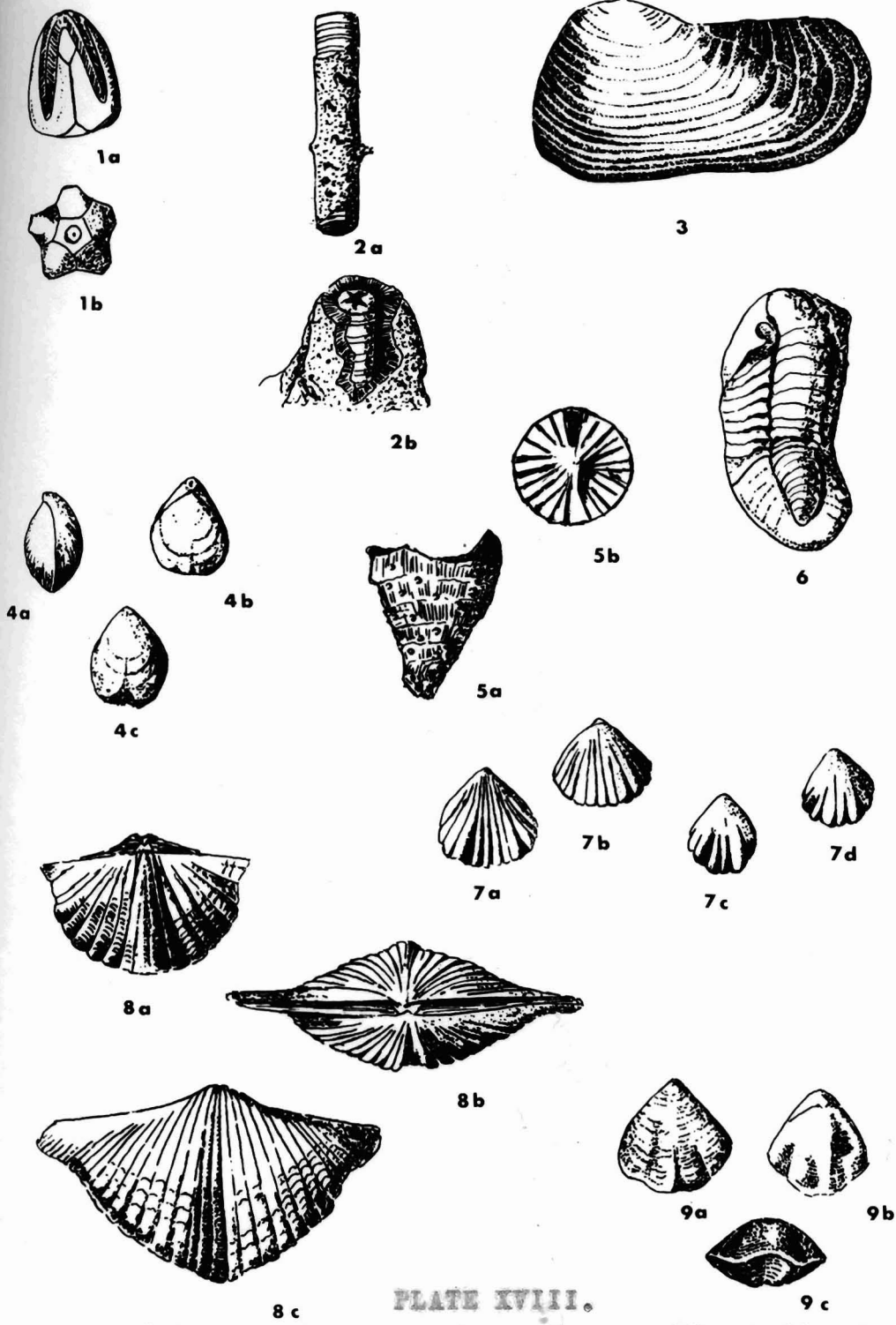


PLATE XVIII.

Upper Middle Mississippian Miscellanea (The Pella Fauna)

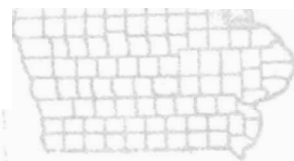
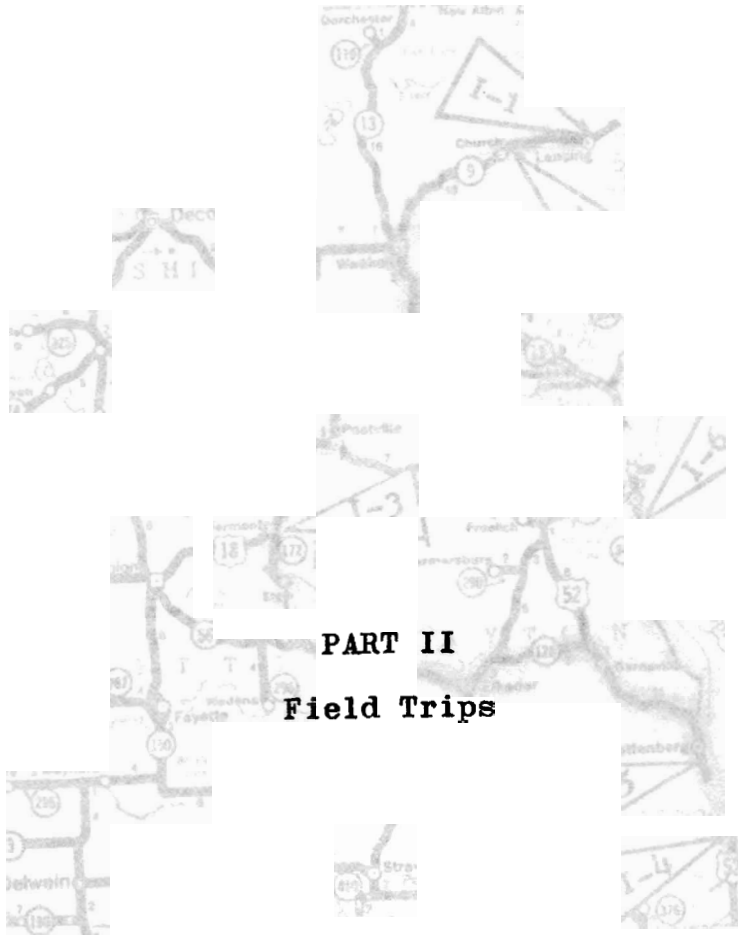


Fig. 7. Trip I Route Map

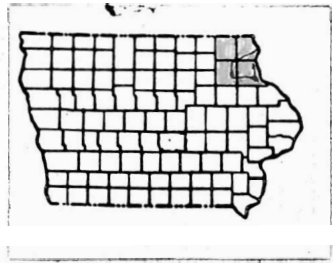
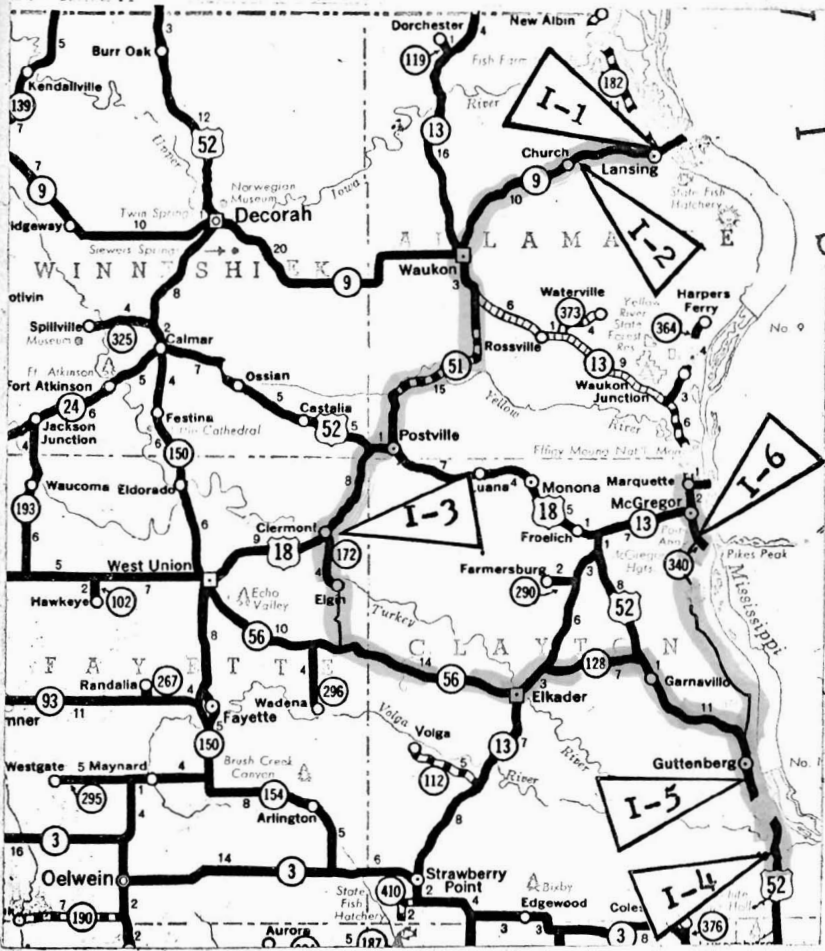


Fig. 7. Trip I Route Map

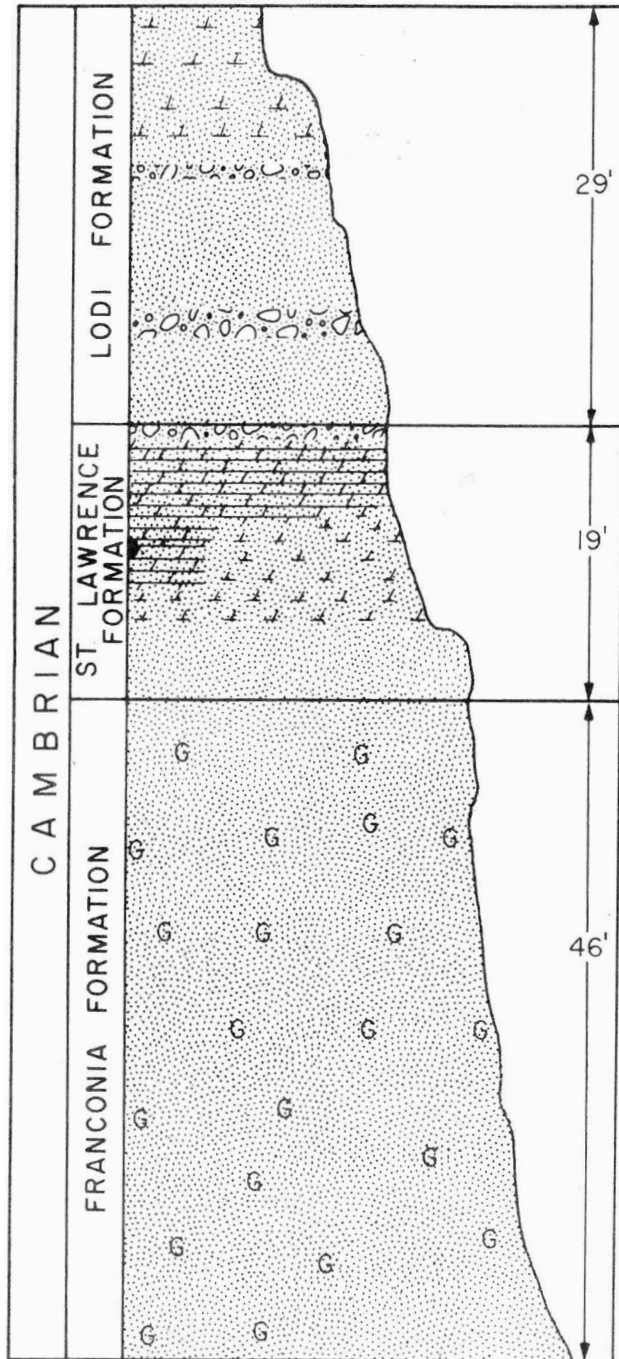


Fig. 8. Section at Fire Bell Hill

TRIP I

## CAMBRIAN AND ORDOVICIAN

## Northeastern Iowa

Assembly is suggested at or near the intersection of North Main Street and Second Street (State Highways 9 and 182, respectively) in Lansing, Allamakee County. The six suggested stops (Fig. 7) will take a full day.

Stop 1. Lansing, Allamakee County. At Fire Bell Hill, on State Highway 182 just north of Lansing [SE 1/4, NE 1/4, SE 1/4, Sec. 29, T. 99 N., R. 3 W., Allamakee County] there is exposed a sequence of Upper Cambrian rocks. The green-colored sandstone at road level is the Franconia Formation (Fig. 8). Overlying this formation are sandstones, siltstones and dolomites of the Trempealeau Group. Fossils have occasionally been found in the topmost thirty feet of the bluff.

Route to the next stop: Proceed south out of Lansing on State Highway 9 and continue about seven miles to a roadcut north of the village of Church for Stop 2.

Between Lansing and Church, rocks of the Jordan Formation



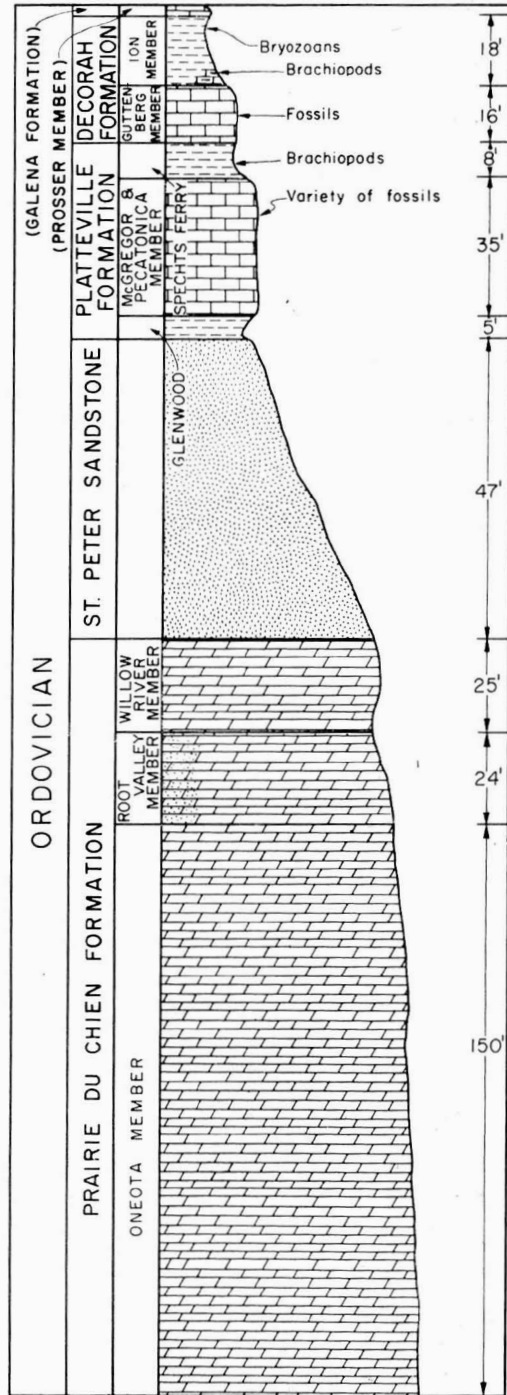


Fig. 9. Section at Church

(the uppermost Cambrian of Iowa) and the Ordovician formations from the Prairie du Chien to the Prosser are exposed in roadcuts along State Highway 9.

Stop 2. Church, Allamakee County. In a section covering about six-tenths of a mile along State Highway 9, north of the town of Church [S 1/2, Sec. 28, T. 99 N., R. 4 W., Allamakee County], the Ordovician rocks from the Root Valley Member of the Prairie du Chien Formation to the Prosser Dolomite Member of the Galena Formation are exposed. Brachiopods, bryozoans, and other megafossils (those visible to the naked eye) may be collected here. These formations will be seen at other localities on this trip, and the fossils will be described in more detail at Stops 5 and 6 (Guttenberg and McGregor). It is suggested that notes be made on the types of rocks and their thicknesses (see Fig. 9), and on the nature of the fossils in the various beds, for comparison with the situation at other stops (see Figs. 13 and 15).

Route to the next stop: Follow State Highway 9 to Waukon; take State Highway 13 south out of Waukon to the junction with State Highway 51; take State Highway 51 to Postville and the junction of Highway 51 with combined U. S. Highways

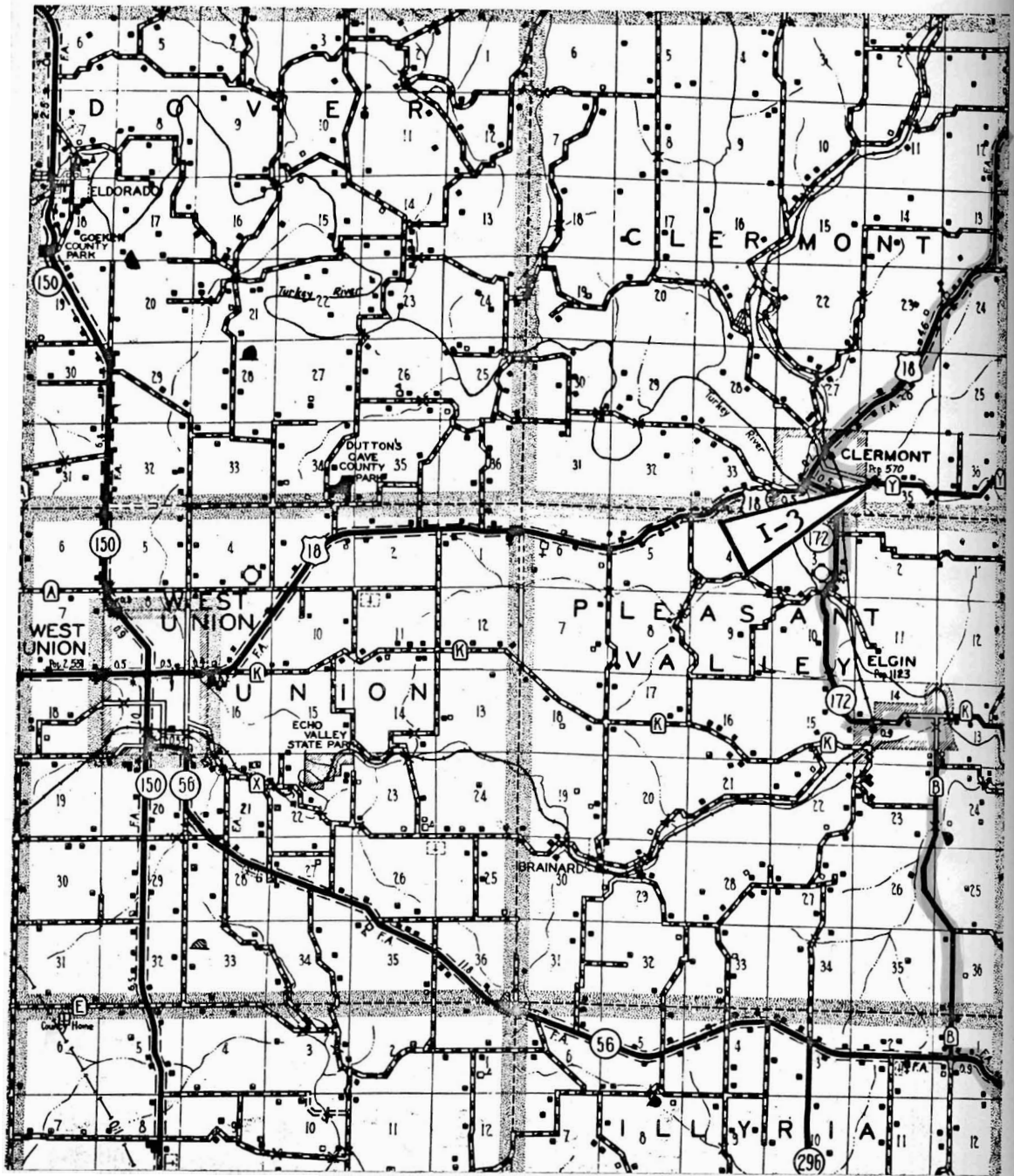


Fig. 10. Map of Clermont Area

52 and 18; keep on U. S. Highway 18 to the town of Clermont (see Fig. 10); turn south and east on County Road Y on the eastern side of Clermont and continue for about one mile to a bridge over a small creek for Stop 3.

Stop 3. Clermont, Fayette County. On Fayette County Road Y, about one mile east of Clermont [Near Center of W. line, Sec. 35, T. 95 N., R. 7 W., Fayette County] in a stream cut is an exposure of the lower beds of the Maquoketa Formation. Fragments of the trilobite Isotelus are common, and occasional whole specimens may be found. Most of these fragments represent pieces of the shed shells of the trilobites. Other trilobites, nautiloid cephalopods and conularids (organisms probably related to the scyphozoan coelenterates) are rarer faunal elements. Graptolites are present generally as small broken pieces which appear as black specks disseminated through the rock, for the most part in the same layers which are rich in trilobites. Rare whole or uncrushed specimens may be found.

The Maquoketa Formation is rarely exposed except in new road cuts, and in streams where slumped material is continually removed. The largely unresistant materials which compose it (shales with occasional limestone lenses)

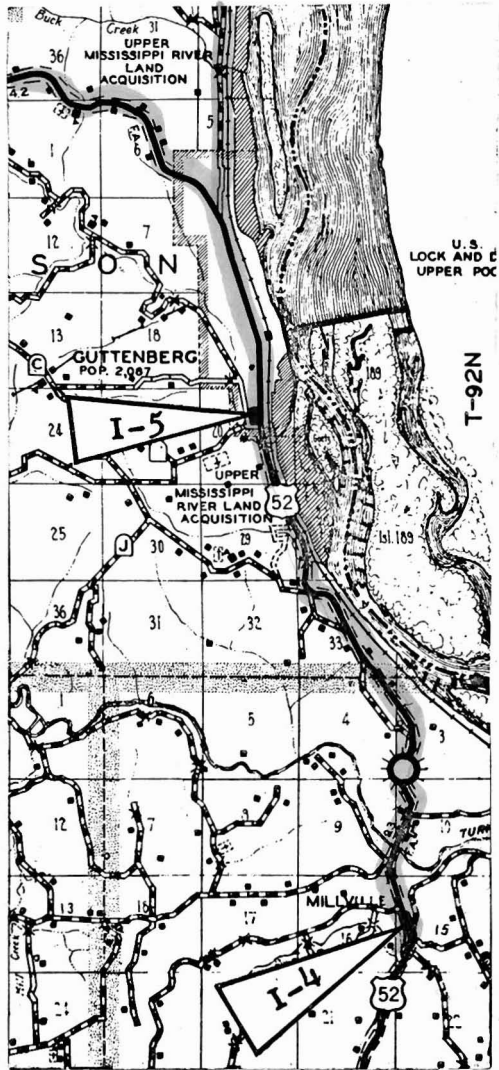


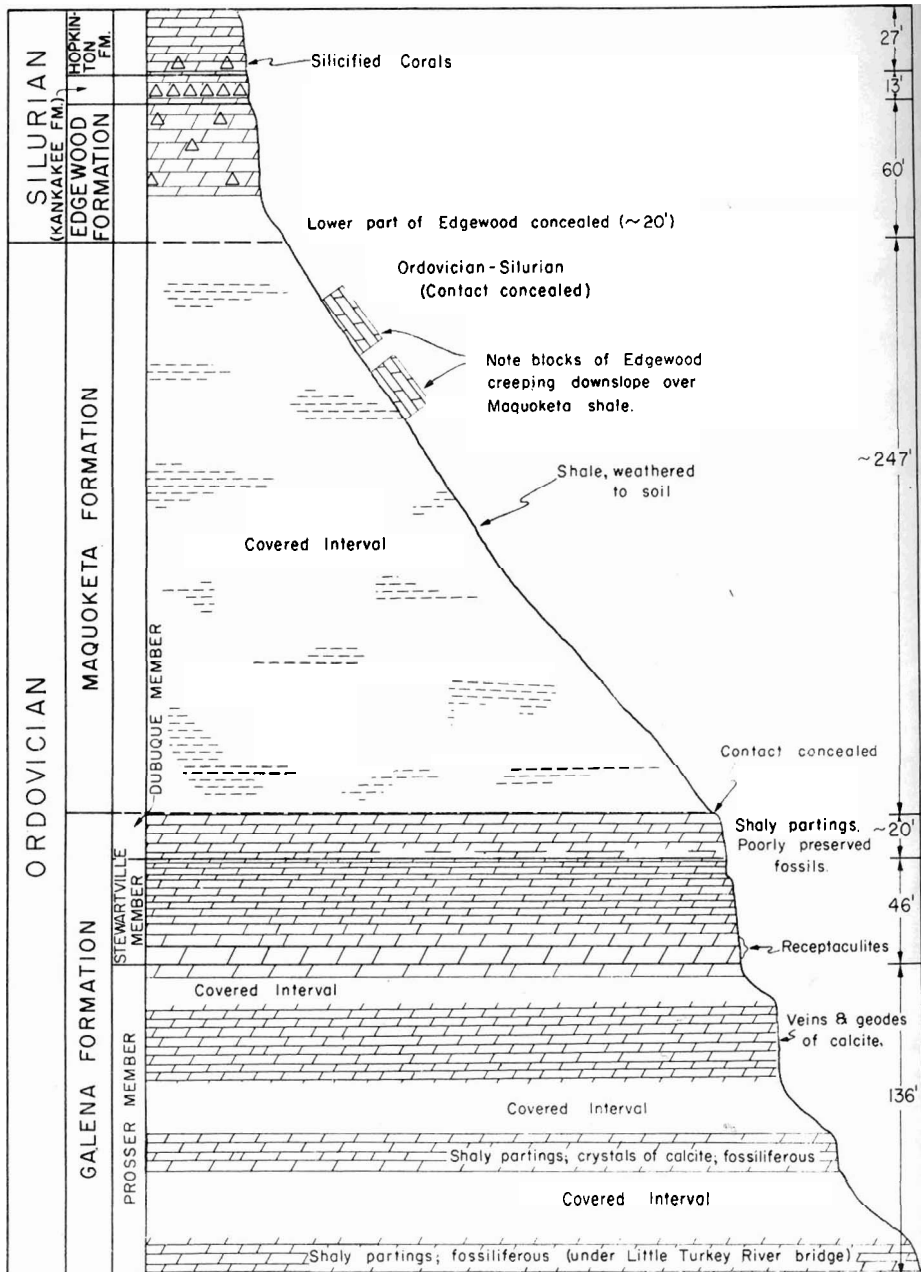
Fig. 11. Map of Guttenberg-Millville Area

quickly become grassed over.

Route to the next stop: Return to Clermont and turn south on State Highway 172 to Elgin. Cross the Turkey River and continue south out of Elgin on County Road B to State Highway 56. Follow Highway 56 to Elkader; turn north at Elkader on State Highway 13 to the intersection with State Highway 128. Follow Highway 128 to U. S. Highway 52, and continue on Highway 52 south through Guttenberg to Stop 4 at Millville.

Note that the exposures at the top of the hill north of Guttenberg are in the Prosser Dolomite Member of the Galena Formation; those at the base of the hill are in the Pecatonica Member of the Platteville Formation. Southward along Highway 52 somewhat younger formations are traversed, and at Millville the rocks which cap the bluffs are Silurian in age. Examination of the Guttenberg section is suggested after the visit to the Millville section.

Stop 4. Millville, Clayton County. On the hill on U. S. Highway 52, about one mile south of the town of Millville [NE 1/4, NE 1/4, Sec. 21, T. 91 N., R. 2 W., Clayton County] is exposed a sequence from the Prosser Dolomite Member of



**Fig. 12. Section at Millville**

the Galena Formation at the base of the hill, to the Hopkinton Formation of Silurian age at the top (see Fig. 12). Note that the Prosser Dolomite was exposed at the top of the hill at Guttenberg, some six miles to the north, whereas the top of the hill at Millville represents the edge of a Silurian escarpment, similar to that just south of Dubuque. Note also that the Maquoketa Formation, seen at Stop 3, is covered with grass here; blocks of the overlying Silurian dolomite may be seen creeping downhill over these plastic shales.

Receptaculites may be collected about 60 feet (vertical measure) below the lower contact of the Maquoketa Formation (Fig. 12). Fossils, particularly corals, occur in the 27 feet of Hopkinton Dolomite at the top of the hill; these fossils are Silurian in age.

Route to the next stop: Turn back north along U. S. Highway 52 to Guttenberg. Proceed down the steep hill south of the town to Clayton County Road C (see Fig. 11), a gravel road which bears west from the Highway, for Stop 5.

Stop 5. Guttenberg, Clayton County. In the angle between U. S. Highway and County Road C, on the north side of the



ORDOVICIAN

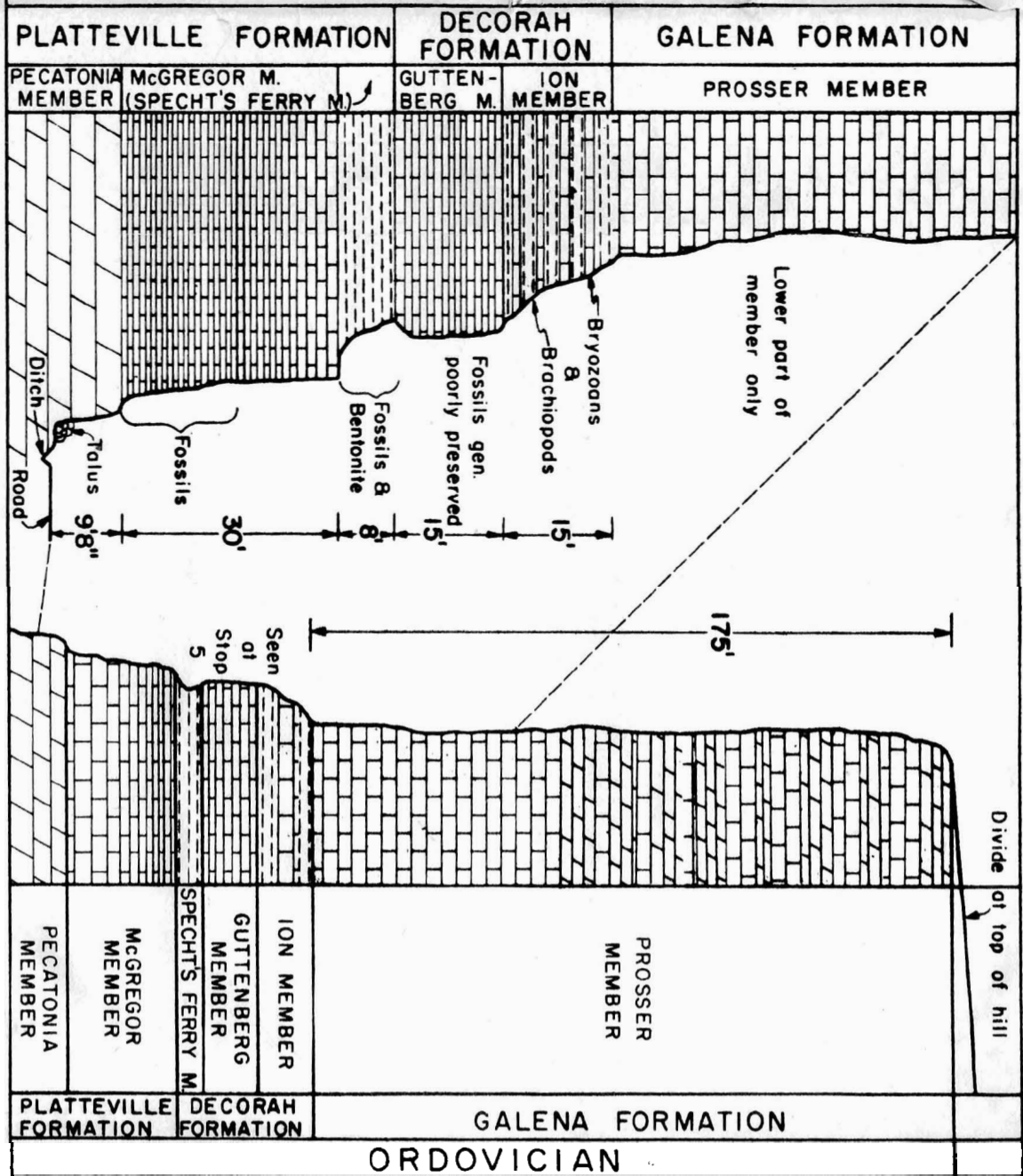
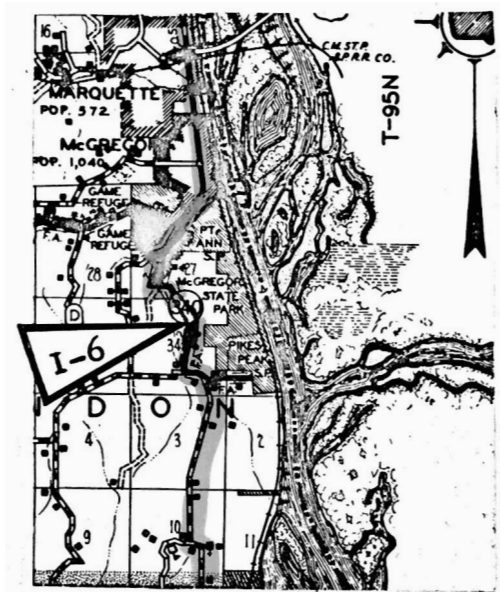


Fig. 13. Section at Guttenberg

intersection, is a high, narrow bluff [SW 1/4, NE 1/4, Sec. 26, T. 92 N., R. 2 W., Clayton County]. Collecting may best be done on that face of the bluff which rises above a small gravel road along Miners Creek. (Use extreme caution when climbing this face, especially after rainy weather; rock falls commonly occur). The easiest, and generally the best collecting is in the talus material along the foot of the bluff.

Although material from any of the formations from the Pecatonica Dolomite to the Ion Shale may be found in the talus (see Fig. 13a), the Pecatonica is only sparsely fossiliferous. Above this generally thick-bedded unit lies the gray to buff, thin-bedded McGregor Limestone, from which the bulk of the slabs in the talus are derived. It contains many brachiopods such as Rafinesquina cf. R. alternata, Hesperorthis tricenaria, trilobite cephalons and pugidia (heads and tails, respectively) from Ceraurus pleurexanthemus, Iliaenus americanus and others, the large ostracod Eoleperditia fabulites the snails Sinuities and Phragmolites, many bryozoans and a number of corals. Compare this rock unit and its fossils at this locality with the same unit at Church (Stop 1) and later with those from McGregor (Stop 6).



**Fig. 14.** Map of McGregor-Marquette Area

Above the McGregor Limestone Member of the Platteville Formation lies the green, clayey Specht's Ferry Shale Member, a unit about eight feet thick. It is generally crowded with small brachiopods such as Doleroides pervetus and Pionodema subaequata, two forms which closely resemble each other and are called homeomorphs. This member weathers rapidly and is therefore only rarely found as slabs in the talus; it must be collected in place from the cliff face, where it forms a re-entrant (see Fig. 13). In the overlying Guttenberg Limestone Member of the Decorah Formation, which may also be found as slabs in the talus, there is an assortment of fossils, generally rather poorly preserved and broken, however. The pelecypod Ctenodonta compressa is among these; it generally occurs as a natural external mold. The overlying Ion Shale Member of the Decorah Formation contains brachiopods and bryozoans, but comprises only a small proportion of the talus material, and cannot be readily reached in place; it can be seen better at the next stop.

Route to the next stop: Continue north on U. S. Highway 52 about one mile to the junction with The Great River Road; follow this north to the junction with the road to Pike's Peak State Park (State Highway 340) just south of McGregor.

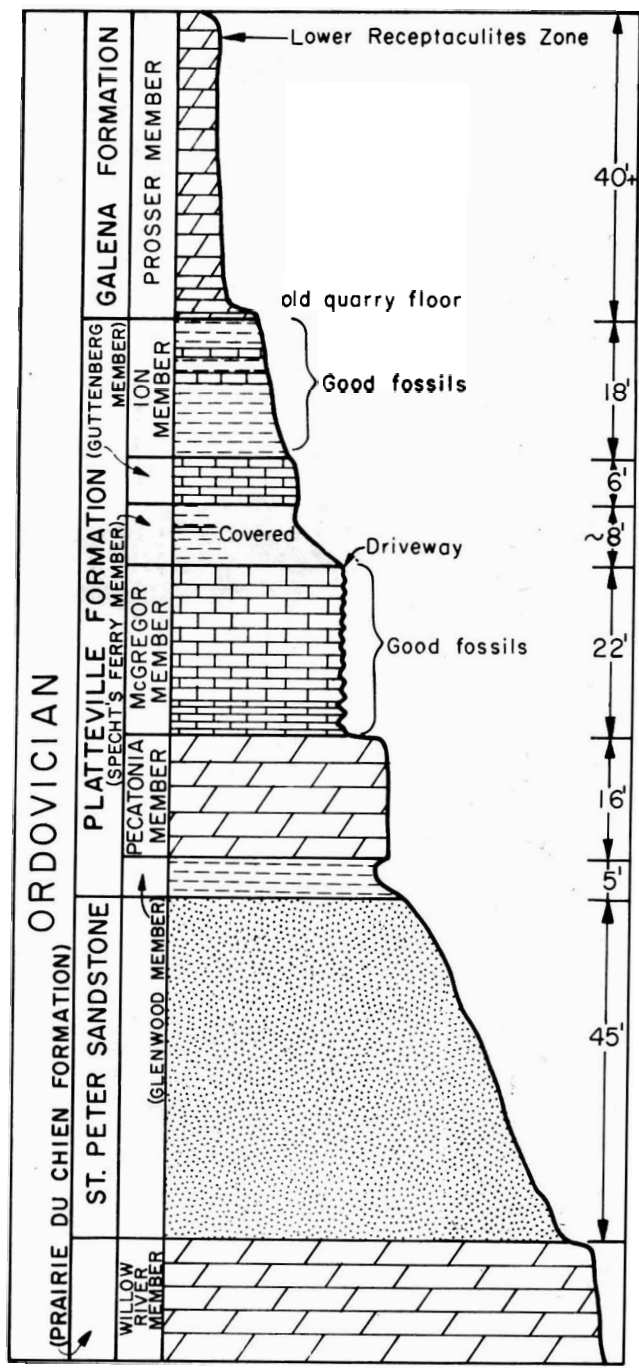


Fig. 15. Section at Pike's Peak Roadcut

Continue on State Highway 340 towards McGregor about half a mile (see Fig. 14) for Stop 6.

Stop 6. McGregor, Clayton County. The section exposed at this roadcut [SE 1/4, SW 1/4, Sec. 27, T. 94 N., R. 3 W., Clayton County] is similar to that seen at the previous stop (see Fig. 15, and compare with Fig. 13). However, the Spechts Ferry Shale is covered here (there is a driveway occupying the covered interval which represents the unit). The Ion Shale Member of the Decorah Formation, however, is exposed near the top of the hill, and contains an abundant fauna, including such brachiopods as Sowerbyella curdsvillensis and many bryozoans, among them Prasopora insularis, the "gumdrop" or "Chinese hat" bryozoan.

The difference between the thick-bedded Pecatonica Dolomite Member and the thin-bedded McGregor Limestone Member of the Platteville Formation is well displayed here. This is the kind of lithologic distinction (which is even more pronounced in the Glenwood and Spechts Ferry Members of the same formation) on which subdivision into members is based. This distinction cannot be made in these units at Church (Stop 1), where separate members are therefore not recognized.

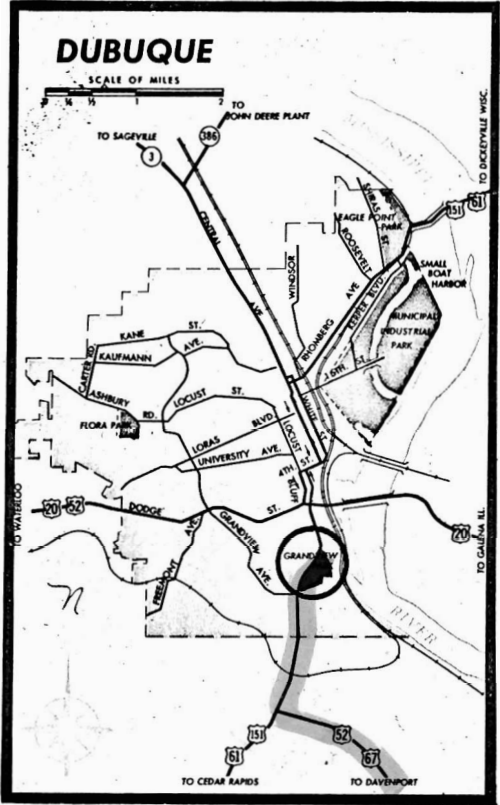
The St. Peter Sandstone in this vicinity is often brightly colored, largely by iron oxide, and in an abandoned small quarry beside the road, downhill from the McGregor and recatonica Members, distinct red color bands may be traced for a number of feet horizontally through the sandstone along the rear wall of the quarry. Even greater color variation is displayed in the exposure of the St. Peter Sandstone in Pike's Peak Park.

This is the last suggested stop. Should you proceed through Marquette (about two miles north of McGregor), note that the sandstone exposed in the roadcut between McGregor and Marquette is the uppermost Cambrian Jordan Sandstone.

This trip has started in the Cambrian, proceeded upwards in the geologic column through the Ordovician and into the Silurian at one stop, then back down through the Ordovician and into the Cambrian again. Geographically, it has gone generally south and then back north again. Refer to the geologic map of Iowa (rear pocket), and note the outcrop pattern of these rocks, produced by a slight regional dip to the southwest.







**Fig. 17. Dubuque City Map**

TRIP II

## ORDOVICIAN AND SILURIAN

## Northeastern and East-Central Iowa

Grandview Park on the southern outskirts of Dubuque (see Fig. 17) is suggested as a convenient assembly point. Rocks exposed in the park belong to the Ordovician Galena Formation, and are composed largely of dolomite.

The four suggested stops (Fig. 16) can probably be covered in half a day. To get to the first stop, go south along U. S. Highway 52 about one mile to Stop 1, a roadcut exposing the Galena Formation.

Stop 1. Dubuque South Roadcut, Dubuque County. In the bluffs lining the road along combined U. S. Highways 52 and 67 here [NE 1/4, Sec. 1, T. 88 N., R. 2 E., Dubuque County] the Stewartville and Dubuque Members of the Galena Formation are exposed, with some of the Prosser Member at the base of the hill. That latter unit can be recognized by the presence of nodular chert. The Upper Receptaculites Zone occurs near the base of the Stewartville (middle) Member of the formation. This zone occurs at road level about midway along the cut.

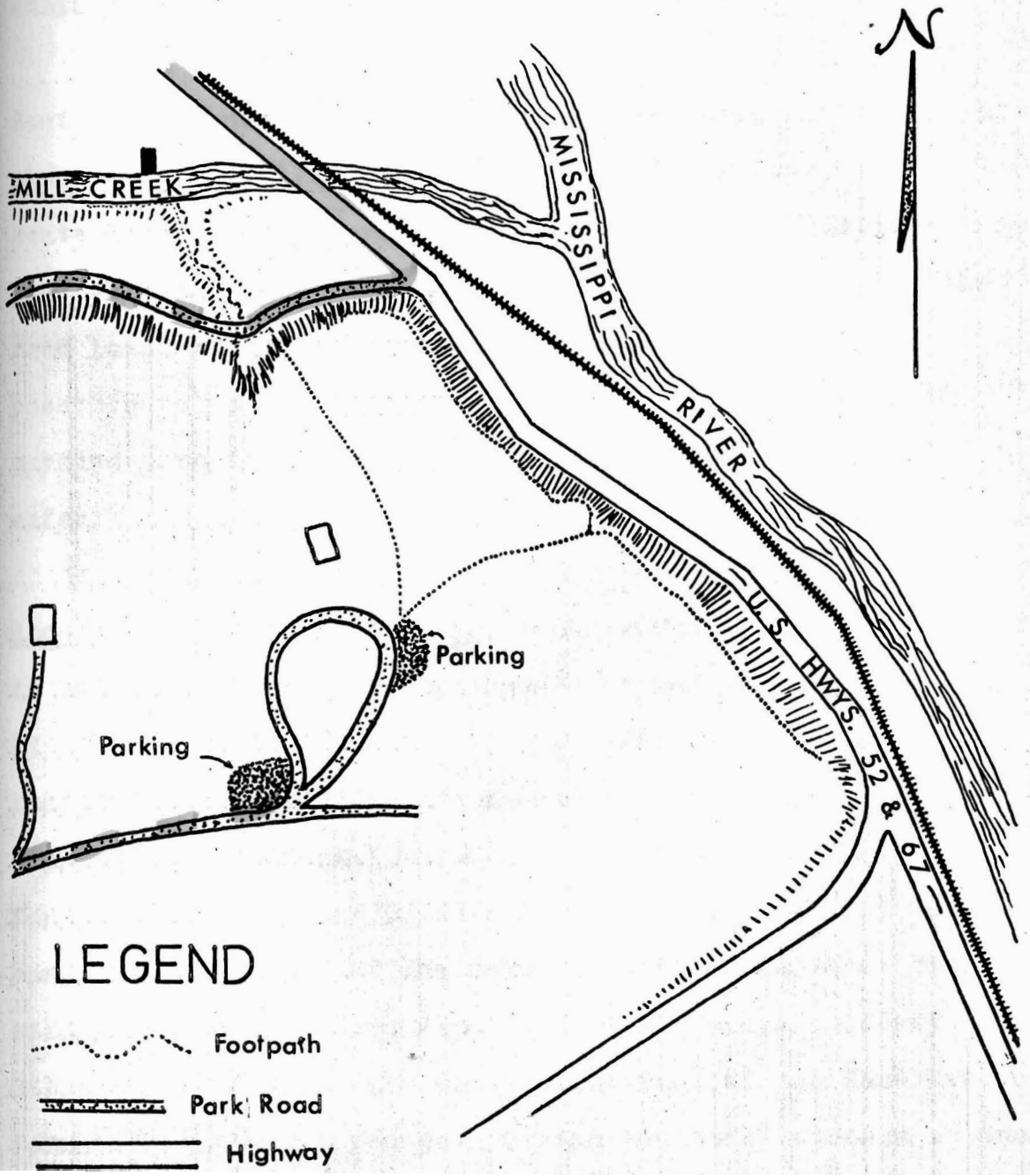


Fig. 18. Dubuque Area (Stops 1 and 2)

Route to the next stop: Continue south out of Dubuque on U. S. Highway 52 about seven and a half miles to the community of King, Dubuque County, for Stop 2.

Stop 2. King Roadcut, Dubuque County. A long road cut south of the community [SE 1/4, Sec. 27, T. 88 N., R. 3 E., Dubuque County] on U. S. Highway 52 exposes three of the four Silurian formations of Iowa: the Edgewood, Kankakee and Hopkinton Formations. The uppermost Ordovician Maquoketa Shale lies not far under the lowest exposed Silurian beds, but slumping has covered it.

The fourteen feet of buff to red dolomite at the top of the cut belong to the Hopkinton Formation, of Niagaran (Middle Silurian) age. Numerous fossil corals occur in it, including the chain coral Halysites, other tabulate corals such as Heliolites, and numerous solitary and colonial rugose corals. Beneath this are fifty-five feet of buff to cream dolomite interbedded with chert; the chert forms continuous layers. This is the Kankakee Formation, of upper Alexandrian (upper Lower Silurian) age. It has only a very few fossils. The lowermost 70 feet of grayish, argillaceous (clayey, muddy) dolomite is the Edgewood Formation, of lower Alexandrian age. It commonly contains some chert and lumps or nodules of harder dolomite, and rare



### LEGEND


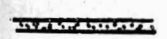
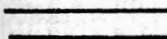
-  Footpath
-  Park Road
-  Highway

Fig. 19. Map of Bellevue State Park

fossils, generally poorly preserved. In some localities, it exhibits ripple-marks.

Route to the next stop: Continue south on U. S. Highway 52 about fourteen miles to Bellevue, Jackson County, where State Highway 62 intersects U. S. Highway 52. Continue past this intersection about eight-tenths of a mile to the road leading into Bellevue State Park, Stop 3. (It is possible to park cars either along the highway, or in the parking area in the Park; the latter alternative is safer.)

Stop 3. Bellevue State Park, Jackson County. It was formerly believed that the rocks exposed in and near the park [N 1/2, Sec. 19, T. 86 N., R. 5 E., Jackson County] included a section from the Maquoketa Shale Formation (uppermost Ordovician) through the Hopkinton Dolomite Formation of Niagaran (Middle Silurian) age. Recent work has shown that most of the dolomite exposed in these bluffs belongs to the Edgewood Formation of Alexandrian (Lower Silurian) age, with only about eight feet of the Kankakee Formation (somewhat younger Alexandrian beds) exposed at the top of the bluff, and no Hopkinton Dolomite present at all.

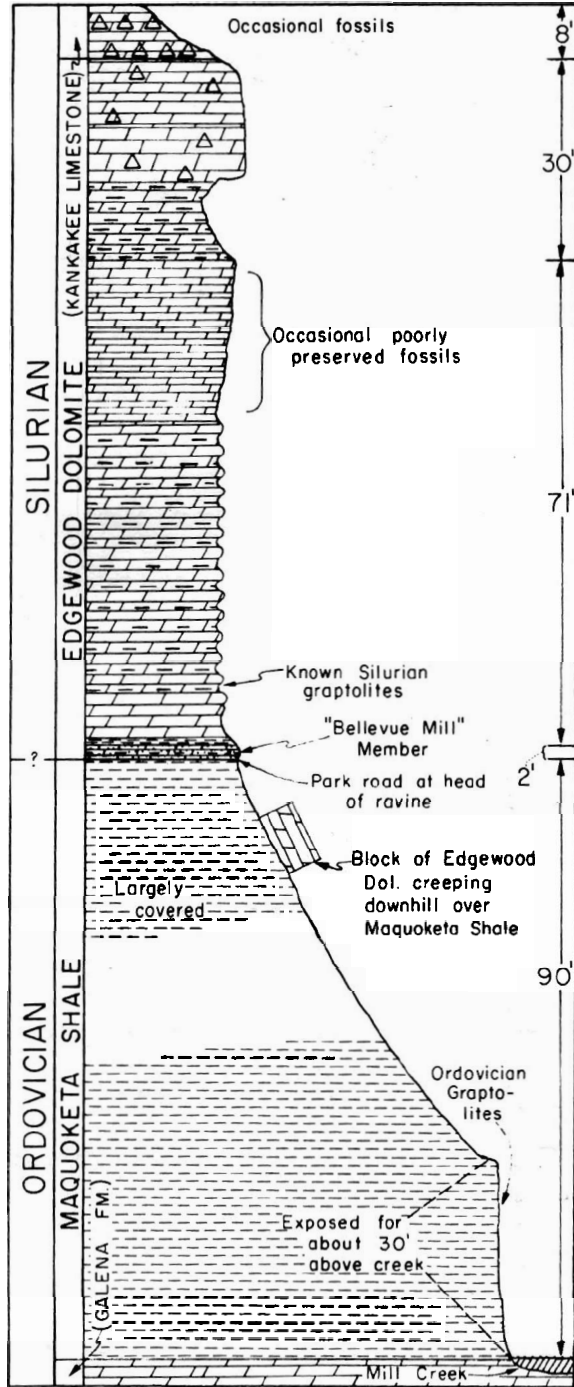


Fig. 20. Section at Bellevue State Park

The Maquoketa Formation is exposed in Mill Creek (see Fig. 19); the rock which forms the creek bed is the top of the Galena Formation (see Fig. 20). The graptolites of the Maquoketa Formation occur in the lower part of the unit which is exposed as a steep shale bank rising from the creek. This formation underlies the tree-covered slope up to the park road, where the Edgewood Formation is found. It is possible that at this locality, the lower few feet of the Edgewood Formation, which appear rather different from the rest of the unit, are actually Ordovician in age. The Maquoketa Formation varies in thickness, as does the Edgewood, being thick where the Maquoketa is thin, and vice versa. Evidently there was a period of erosion between the time the uppermost Maquoketa beds were deposited and the time the lowermost Edgewood beds were laid down. About twelve feet above the contact between the Edgewood and Maquoketa Formations is a zone from which graptolites have been collected; they are, however, somewhat difficult to find. These graptolites appear to be lowermost Silurian in age.

Route to the next stop: Return to the town of Bellevue and bear west on State Highway 62 towards Maquoketa. At Maquoketa, jog north on U. S. Highway 61 to State Highway



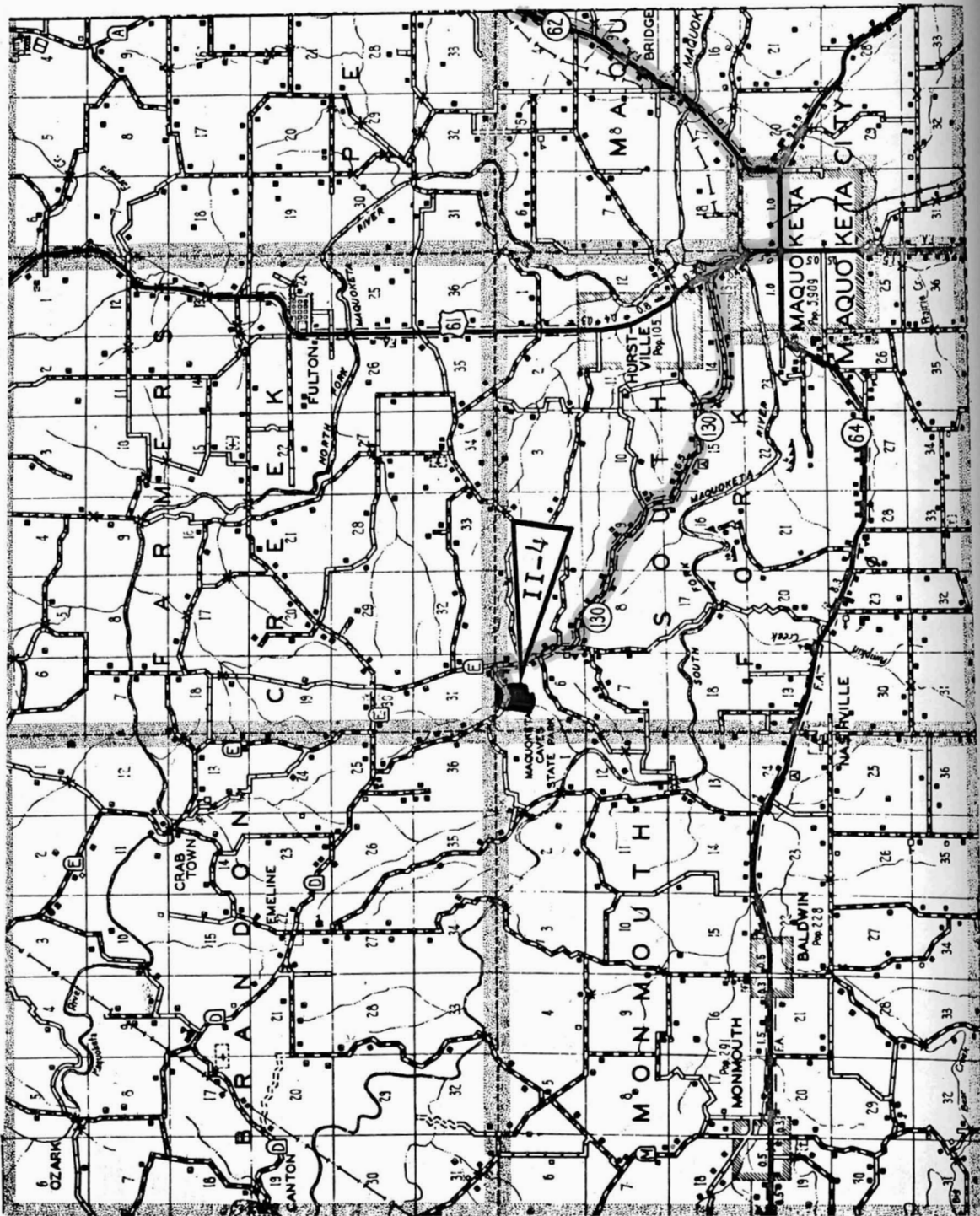


Fig. 21. Map of Maquoketa Caves Area

130; take Highway 130 west for about five miles to the entrance of Maquoketa Caves State Park, Stop 4.

Stop 4. Maquoketa Caves State Park, Jackson County. The Hopkinton Formation is locally subject to extensive solution, as illustrated by this locality. The Maquoketa Caves are perhaps a remnant of a once much more extensive underground drainage system, which may have paralleled the surface drainage of the time. They are thought to have developed during the Pleistocene (glacial) Epoch. Note that collecting is not permitted in state parks.

The easiest return route to Dubuque is back along Highway 130 to U. S. 61, and north on Highway 61 to Dubuque.

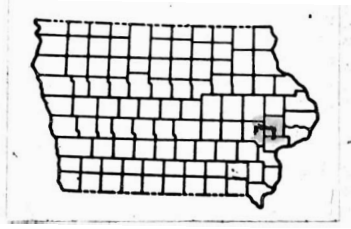
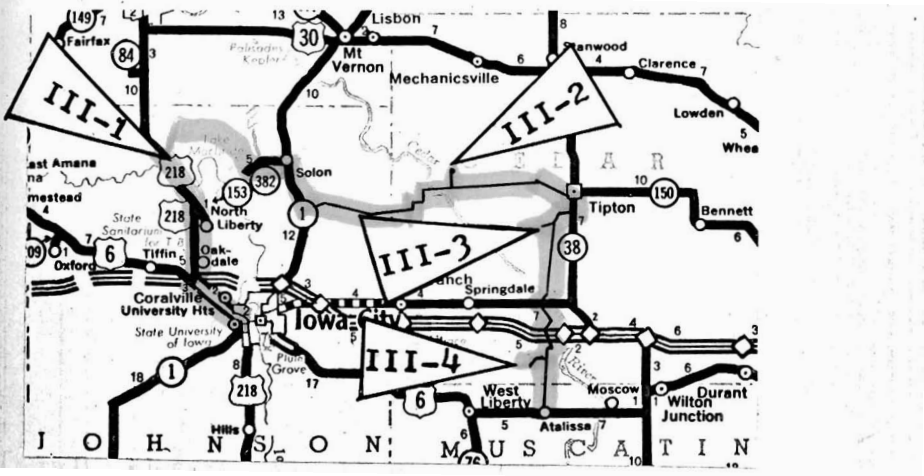
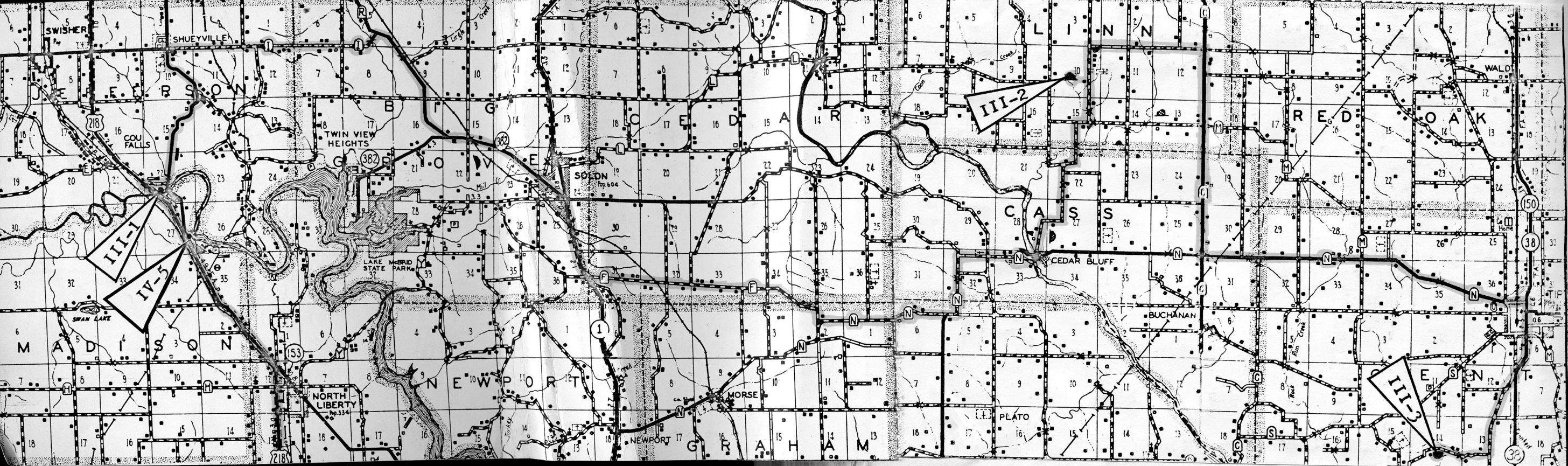


Fig. 22. Trip III<sup>2</sup> Route Map



III-1  
IV-5

III-2

III-3

SWISHER

SHUEYVILLE

L I N C O L N

J A S P E R

TWIN VIEW HEIGHTS

BOONE

C A S S

R E D O A K

M A D I S O N

NORTH LIBERTY

N E W P O R T

MORSE

CEDAR BLUFF

BUCHANAN

PLATO

E S E N

WALD

150

38

32

218

382

153

1

32

TRIP III

## SILURIAN AND DEVONIAN

## East-Central Iowa

Assembly in Iowa City or vicinity is suggested for this trip. The rock exposed in the bluffs along Riverside Drive in Iowa City are part of the Coralville Member of the Cedar Valley Limestone.

The four suggested stops on this trip (see Fig. 22) can be covered in half a day, although more time can be allowed for more extensive collecting. To get to the first stop, proceed north on U. S. Highway 218 from the U. S. Highway 6 intersection west of Iowa City. Stop 1, Curtis Bridge Quarry, is about ten miles north of this intersection.

Stop 1. Curtis Bridge Quarry, Johnson County. At this abandoned quarry [NW 1/4, Sec. 22, T. 81 N., R. 7 W., Johnson County] is exposed the Coralville (uppermost) Member of the Cedar Valley Limestone. The "Coralville biostrome" or "life-layer" ("coral meadow") is displayed here; many solitary and compound corals such as Hexagonaria and Favosites and numerous stromatoporoids can be found, as well as the pelecypod Conocardium and occasional fragments

(commonly the pygidia, or tails) of a Proetus-like trilobite. The organisms of this horizon closely approximate the original living community, and are not just a concentration of dead specimens washed in from some other area. At the top of the larger quarry is a section of loess and glacial till, and striations made by the glacier can be seen on the bedrock surface where the till has been stripped away. (Please do not damage this small exposed area of glacial pavement.)

Route to the next stop: Take the old highway north from the Curtis Bridge locality to Shueyville (see Fig. 23); at Shueyville bear east on Johnson County Road I to the intersection with County Road R. Bear southeast on County R to the intersection with State Highway 382 and proceed east to Solon. Go south from Solon on State Highway 1 about one and a half miles to the intersection with County Road F; bear east on County F to County Road N, and follow County N into Cedar County (it remains County N across the County line) and follow it to Cedar Bluff. Cross the Cedar River in Cedar Bluff and turn north. Follow this road to a T-junction and take the right-hand (east-bearing) branch. Take the first left turn (north) and follow this road about one mile to Stop 2, the Hunt Quarry.

Stop 2. Hunt Quarry, Cedar County. At this quarry [Center of Sec. 10, T. 81 N., R. 4 W., Cedar County] a Silurian bioherm or "life mound" (a so-called "coral-reef") is exposed. This bioherm has a massive, structureless core, part of which has been left standing between the two quarry pits. Most bioherms have flank beds that dip steeply away from the core; these flanks are only poorly exposed at Hunt Quarry. Numerous fossils are available in the core rock, and the preservation is much better than at the next stop. There are many corals and stromatoporoids, a number of nautiloid cephalopods such as Phragmoceras, brachiopods and clams. Crinoid stems, isolated columnals (stem fragments), and occasional cups, including the genus Eucalyptocrinites also occur. The rock unit is the Gower Formation, a younger Silurian formation than any seen on Trips I or II. It is divided into two facies, the reef and the inter-reef facies. The former is called the LeClaire phase, and the latter, the Anamosa phase. Both are quarried extensively. The LeClaire is used mainly for concrete aggregate, and the Anamosa for building stone. The Gower Formation is generally considered to be upper Niagaran (upper Middle Silurian) in age.

Route to the next stop: Continue north on the same road

about one half mile to the first east-bearing road. Take this to Cedar County Road C (about one and a quarter miles). Take County C south to County N, and bear east on County N to Tipton. Take Highway 38 south out of Tipton for about a mile to the first southwest-bearing (diagonal) road. Follow this to the southwest for about a mile and a half to the intersection with a west-bearing road. Follow this about one mile to Stop 3, Brady Quarry, operated by DeWeese-Pothoff. The quarry is on the south side of the road. (See Fig. 23 for route.)

Stop 3. Brady Quarry, Cedar County. This quarry [SW 1/4, Sec. 14, T. 80 N., R. 3 W., Cedar County] is also in the LeClaire phase of the Gower Formation, and exposes another bioherm. The change in dip of the flank beds from nearly horizontal at the quarry entrance to very steep next to the core (on the south wall of the quarry) is excellently displayed. Small "satellite" reefs may be seen adjacent to the main reef core. Most of the fossils in the core have been removed by solution, leaving cavities; some of these may be lined or filled with crystals, whereas others are empty or are filled with clay. Brachiopods can generally be collected here in fair abundance; some may have the spiral brachidium (support for internal organs) preserved.



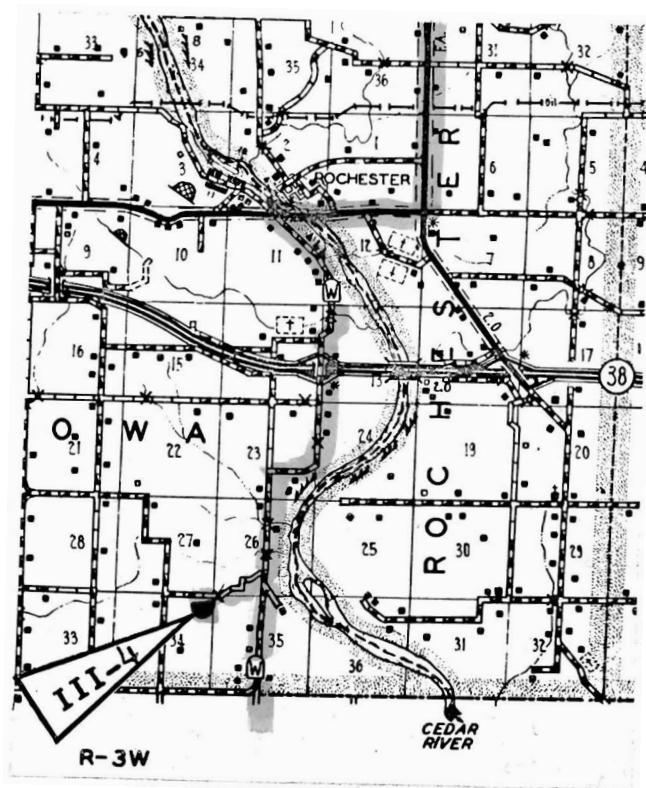


Fig. 24. Rochester-Atalissa Area

Internal structures are, of course, visible only on broken specimens.

This is a working quarry; be sure to arrange permission in advance from the Deweese-Pothoff Company.

Route to the next stop: Return to State Highway 38 and proceed south to Rochester and the intersection with State Highway 1 (see Fig. 24). Bear west on Highway 1; cross the Cedar River, and bear south on the first left road (County Road W, about one-quarter mile beyond the bridge). Continue south on Cedar County W about four and three-quarters miles. The Cedar River can be seen to the east (left) and an unpaved road bears west along a low valley. There is a broken windmill on the southwest corner of the intersection. Follow this road west and southwest about one-half mile to Stop 4, a small quarry on the south (left) side of the road.

Stop 4. Atalissa Quarry, Cedar County. This quarry [NE Corner, Sec. 34, T. 79 N., R. 3 W., Cedar County] is in the Rapid and Solon (middle and lower, respectively) Members of the Cedar Valley Formation (the upper member was seen at Stop 1). The Solon Member is generally under water in this

quarry; the water is about 25 to 30 feet deep, and only a few feet of the quarry face are exposed above water level. The pit is drained periodically for quarrying operations. The best fossil collecting is in the aggregate piles. Excellent brachiopods, bryozoans and corals may be obtained. Several species of Atrypa, Mucrospirifer and Platyrachella are among the brachiopods here. Solitary to loosely colonial rugose corals may be found, as well as whole colonies of the tightly-packed rugose Hexagonaria and the tabulate Favosites. Mound-type bryozoans showing monticules also occur.

U. S. Highway 6 may be reached by returning to County Road W and turning south (right).



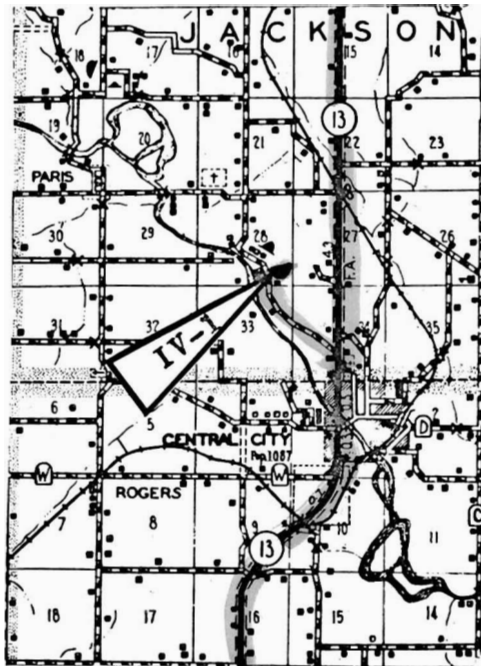


Fig. 26. Map of Central City Area

TRIP IV

## MIDDLE DEVONIAN

## East-Central Iowa

Assembly is suggested at the intersection of State Highways 13 and 151, about six miles northeast of the center of Cedar Rapids, in Linn County. The five suggested stops of the trip (see Fig. 25) will take a full day to cover. To get to the first stop, proceed northward on State Highway 13 to Central City. Go through town, and cross the Wapsipinicon River. About half a mile north of the river, turn west on an unpaved road which runs along the river (see Fig. 26). Follow this road 1.3 miles to Stop 1, a quarry on the northeast (left) side of the road. It is possible to park in the quarry.

Stop 1. Central City, Linn County. A nearly complete exposure of the Wapsipinicon Formation (see Fig. 27) is available at this quarry [NW Corner, SE 1/4, Sec. 28, T. 86 N., R. 6 W., Linn County]. The formation is almost totally unfossiliferous, and consequently its exact age is somewhat in doubt. It is generally considered to be lower Middle Devonian, as it lies above a known Silurian formation (the Hopkinton) and below a known upper Middle Devonian formation

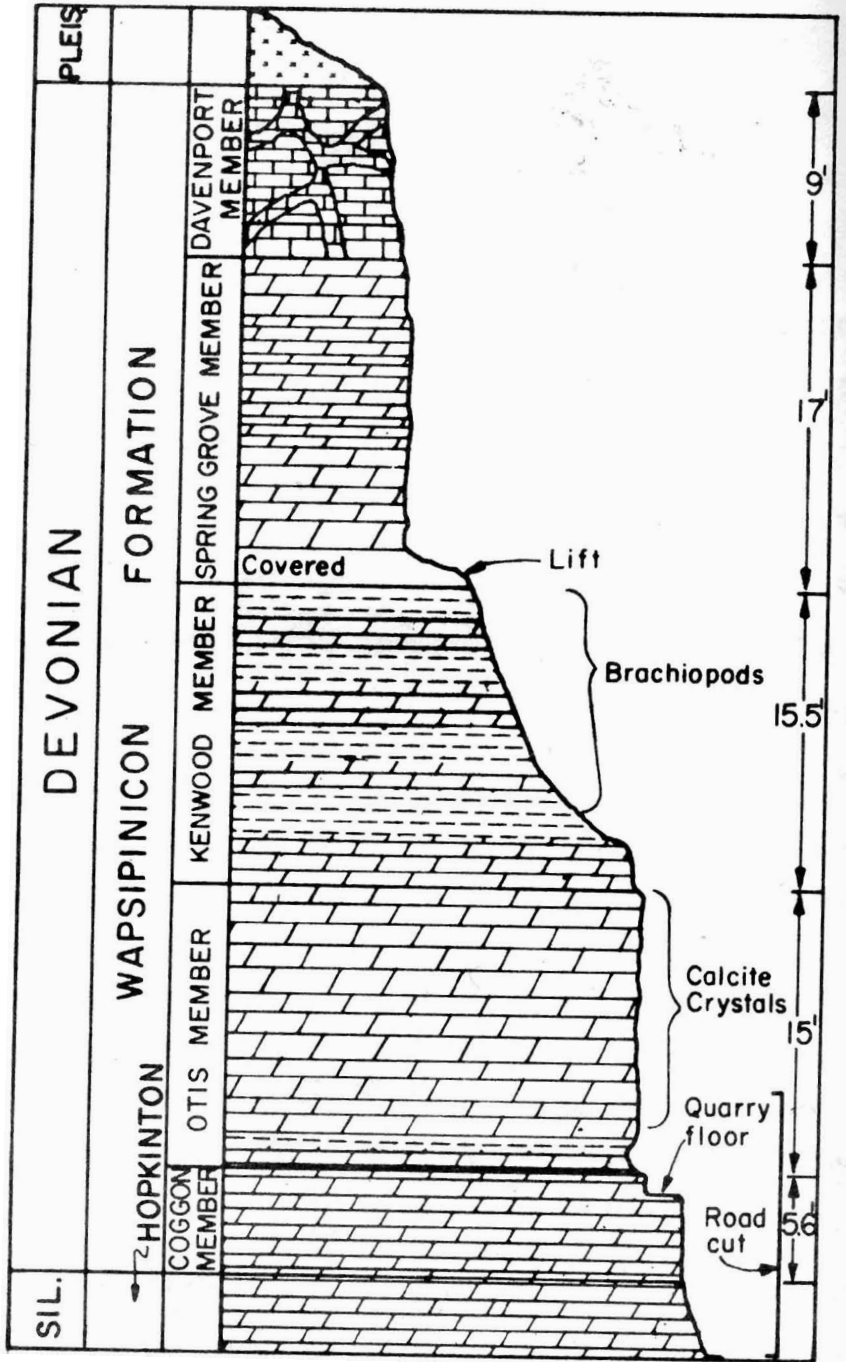


Fig. 27. Section at Central City

(the Cedar Valley). However, since there is no upper Silurian known in Iowa, and since the Gower Formation appears not to be present here, the age of the Wapsipinicon could be anywhere between the upper Middle Silurian and the upper Middle Devonian. A long period of erosion is thought to have taken place after the youngest Silurian beds were deposited.

Brachiopods have been reported from the Spring Grove Member of the Wapsipinicon, but they are poorly preserved, and their time range is not sufficiently restricted to make them helpful in the correlation of the formation. It is unlikely that any would be found at this locality.

Large veins and vugs of calcite occur in the Otis Member, and fine cleavage samples may be collected in place about twelve feet above the quarry floor. Climbing the full height of the face is not recommended.

The topmost nine feet of bedrock is the brecciated limestone of the Davenport Member. This member may also be seen in the deepest part of the quarry at Stop 2. It has been suggested that this is a collapse breccia, formed when some material -- perhaps gypsum -- in the underlying rock was removed by solution, causing the beds above to collapse as support was removed.



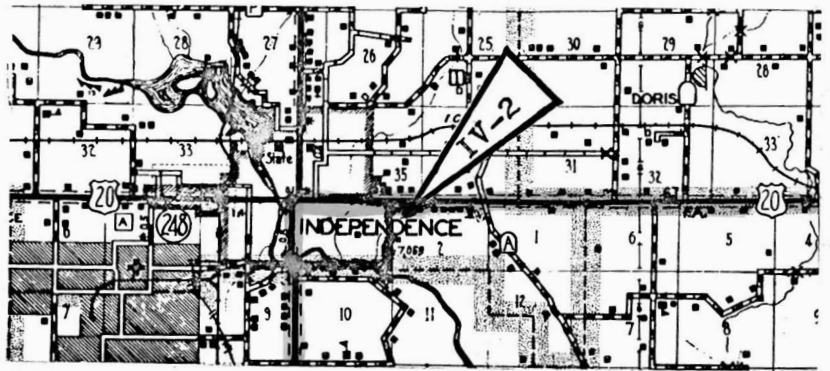


Fig. 28. Map of Independence Area

Route to the next stop: Return to State Highway 13, and turn north; follow Highway 13 about five miles to Coggon, and turn west at Coggon on Linn County Road S. Follow this about twelve miles to Walker; turn north at Walker (Linn County S also turns north, and shortly becomes Buchanan County S) and continue through Quasqueton to U. S. Highway 20. Turn west on Highway 20, and follow it about five and three-quarters miles to quarries on both sides of the Highway (see Fig. 28). Turn south off the Highway and into the quarries for Stop 2. Check at the gatehouse for permission if the quarry is in operation.

Stop 2. Independence, Buchanan County. The Solon (lowest) Member of the Cedar Valley Limestone is exposed in these quarries [NW 1/4, Sec. 2, T. 88 N., R. 9 W., Buchanan County]. The Cedar Valley Limestone is upper Middle Devonian in age, and directly overlies the Davenport Member of the Wapsipinicon Formation, a part of which may be found in the deepest parts of the quarry farthest from the entrance. The Davenport is characterized by a breccia which is present in some layers. Blocks of this breccia show large, angular, light and dark mottling. The Solon Limestone Member of the Cedar Valley Formation is a gray limestone, and is abundantly fossiliferous.

Two zones in the Solon Limestone, based on the fossils present, are fairly distinct. The lower is called the Atrypa independensis Zone, because of the abundance of that brachiopod. In it are found a large number of other brachiopods, among them Platyrachella iowensis. Large coiled and curved nautiloids such as Gyroceras transversum are also found in this zone. The upper zone is called the Prismatophyllum profunda Zone; the name comes from the abundance of a colonial rugose coral now known as Hexagonaria profunda. Many other corals, both colonial and solitary, are found in this zone. Among these are the colonial Billingsastrea billingsi, and a number of solitary "Cystiphyllum"-like forms. Snails may also be found in the upper beds. A zone of "black fossils" (most of them brachiopods) may be exposed near the base of the Solon Limestone in the same deep part of the quarry where the Davenport breccia was found.

White, orange and brown calcite also occurs in veins and vugs in the Solon Limestone at this locality.

Route to the next stop: Continue on Highway 20 into Independence. Turn south on State Highway 150 to the junction with State Highway 101 and proceed south on Highway

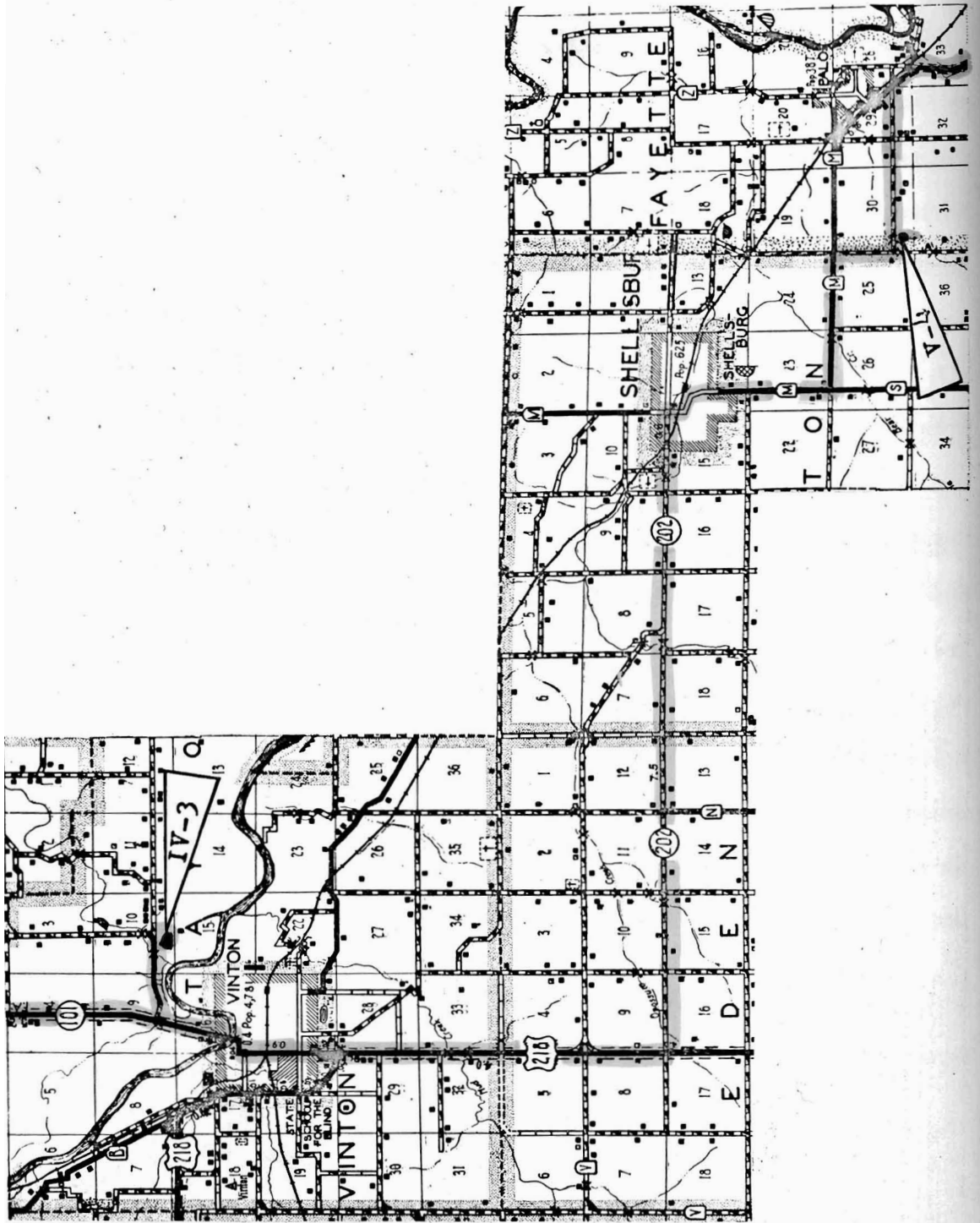


Fig. 29. Map of Vinton-Palo Area

101, following it west and then south again and continuing until just before the bridge across the Cedar River. Bear east (left) on the first road north of the bridge and follow this to Stop 3, a quarry on the south (right) side of the road.

Stop 3. Old Judge Nichols Quarry, Vinton, Benton County.

In this quarry [SE 1/4, SW 1/4, Sec. 10, T. 85 N., R. 10 W., Benton County] is exposed most of the Solon Member of the Cedar Valley Limestone and a few feet (probably about ten) of the overlying Rapid (middle) Member of this formation. The contact between the Solon and Rapid Members is, here and at many localities, difficult to determine exactly. The Rapid is generally cherty and the Solon commonly lacks chert. There are differences in the fossils as well. The large spiriferid, Platyrachella iowensis, Atrypa independensis and the colonial corals Hexagonaria profunda and Billinsastrea billingsi are all in the Solon. Other species of Atrypa and Hexagonaria occur in the Rapid, and at this locality the colonial tabulate coral Favosites and the brachiopod Cyrtina umbonata are most likely to be from the Rapid.

Collecting is good at this locality, particularly on the

more weathered faces of the quarry, where the brachiopods Platyrachella iowensis, Schizophoria meeki, and Atrypa waterlooensis may be found. Some of the forms mentioned above for the Rapid may occasionally be found in the weathered and slumped material; however, the Rapid is rather unfossiliferous here, as contrasted with the situation at the next stop (Palo) and at Atalissa (Trip III, Stop 4).

Route to the next stop: Return to State Highway 101 and turn south through Vinton about four miles to the intersection with State Highway 202. Bear east on Highway 202 to Shellsburg, and there turn south on County Road M (Benton County). Turn east (following County M) after about two miles, and continue to the Benton-Linn County line. Turn south on the County Line Road and, in about three-quarters of a mile, turn east on a gravel road; continue about one-quarter mile, and then turn south on a lane about one-quarter mile to Stop 4, Palo Quarry (see Fig. 29).

Stop 4. Palo Quarry, Linn County. This quarry [NW 1/4, Sec. 31, T. 84 N., R. 8 W., Linn County] has been excavated in a somewhat "domed" biostrome in the Rapid Member of the Cedar Valley Limestone. This "coral bank" was the site of

abundant shallow-water marine life, and the Rapid Member is extremely fossiliferous here. Plates and rare whole specimens of the cystoid Strobilocystites (one of the youngest known cystoids) occur in these beds, as well as numerous brachiopods such as Mucrospirifer and Atrypa. The tear-drop shaped brachiopod Cranaena iowensis may be found displaying color bands; these are thought to represent the color pattern of the original living animal. This type of preservation is extremely unusual. The crinoid Megistocrinus is also known from Palo, and occasional whole cups may be obtained. Many corals, both colonial and solitary, as well as nautiloid cephalopods occur in the quarry floor a few feet above normal water level. Bryozoans are also very abundant, and many have been weathered in such a way as to display details of the structure of the colony and individuals. Colonial tabulate corals of an aulopoid type may be intimately associated with the bryozoans. Both bryozoans and colonial corals may encrust or surround fragments or entire other organisms. Much less common are the remains of proetid trilobites.

Note the slight differences in lithology and fossils in the Rapid Member at the various places it has been observed.

In the past, as at present, conditions varied somewhat from

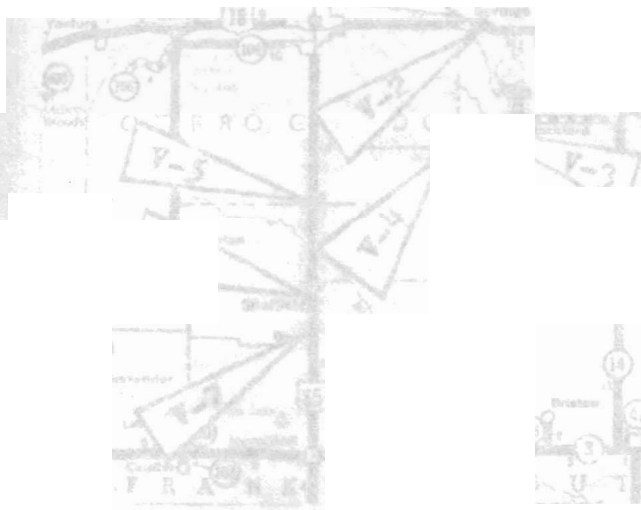
place to place at a given time, as well as from time to time in a single area. This change in physical environment is reflected as variations in rock type and fossil content both laterally and vertically.

Route to the next stop: Return to gravel road and turn east; continue east to the intersection with State Highway 74 and turn south. Follow Highway 74 into Cedar Rapids, and take U. S. Highway 218 south out of Cedar Rapids past Cou Falls to Stop 5, Mid-River (Killian's Marina)(see Fig. 22).

Stop 5. Mid-River Quarry, Johnson County. The pit at this locality [Near Center of E. line, Sec. 27, T. 81 N., R. 7 W., Johnson County] exposes the Coralville Member of the Cedar Valley Limestone, and some of the Rapid Member at the base of the section. The "coral ledges" with their abundant stromatoporoids and colonial and solitary corals are conspicuous. Hexagonaria, a colonial rugose coral, and Favosites, a colonial tabulate coral, are common along with such stromatoporoids as Idiostroma and Stromatopora. Brachiopods and bryozoans, occasional molluscs and rare trilobite pygidia may also be secured.



This is the last suggested stop. An attempt has been made to show the formations of the Middle Devonian, their members, the contacts between them, and the variation in their fossils from locality to locality.



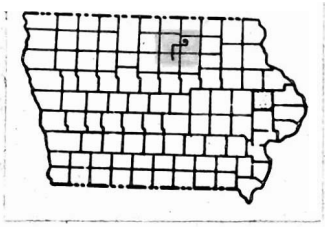
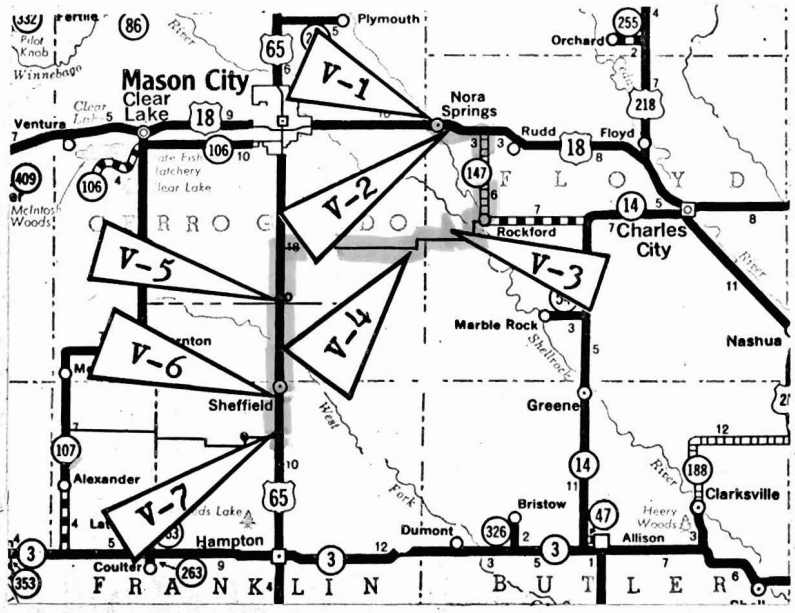


Fig. 30. Trip V Route Map

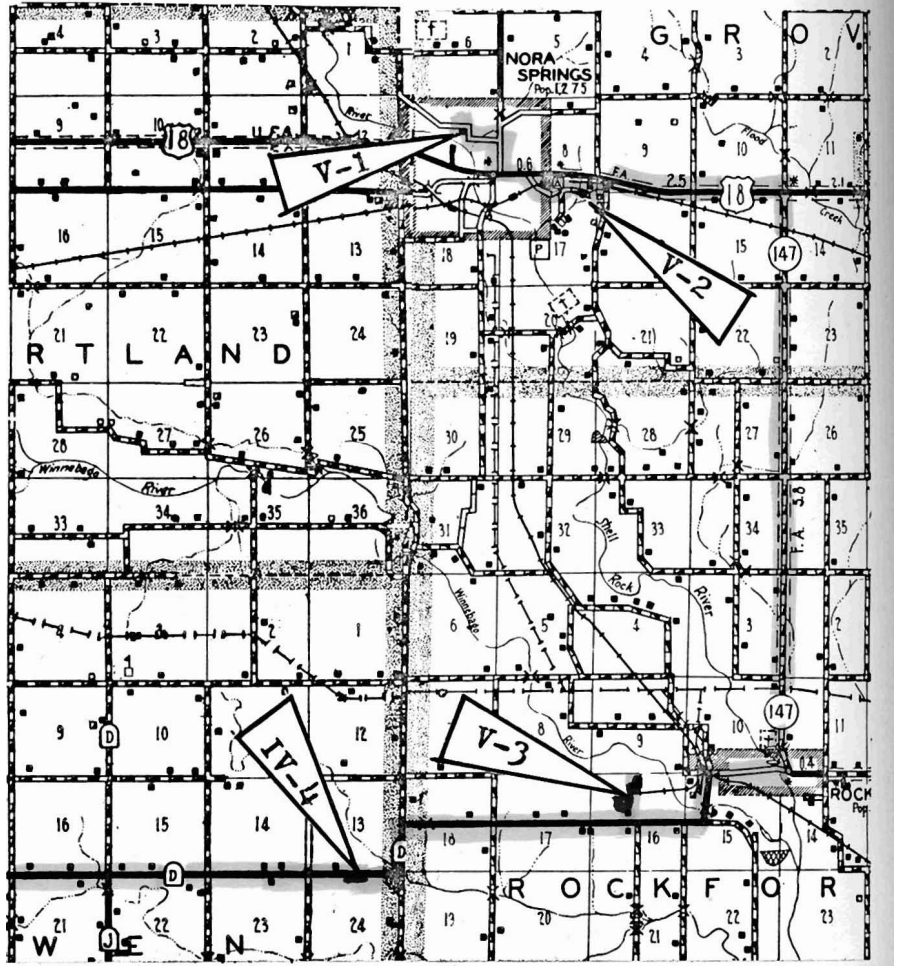


Fig. 31. Map of Nora Springs-Rockford Area

## TRIP V

### UPPER DEVONIAN

#### North-Central Iowa

Assembly is suggested at the city park in Nora Springs, Floyd County, which is also the first stop. The park is north of U. S. Highway 18, along the Shell Rock River.

Note that the Mason City Member (lowest) of the Shell Rock Formation may be seen in contact with the underlying Cedar Valley Limestone under the Highway 18 bridge across the Shell Rock River.

The seven suggested stops for this trip (see Fig. 30) will occupy a full day.

Stop 1. Nora Springs, Floyd County. In the low bluffs along the Shell Rock River in the park [Near Center of Sec. 7, T. 96 N., R. 18 W., Floyd County], the Rock Grove and Mason City (middle and lower, respectively) Members of the Upper Devonian Shell Rock Formation as exposed. This formation directly overlies the Cedar Valley Limestone of upper Middle Devonian age.

Five feet of thin, alternating beds of hard, blue-gray

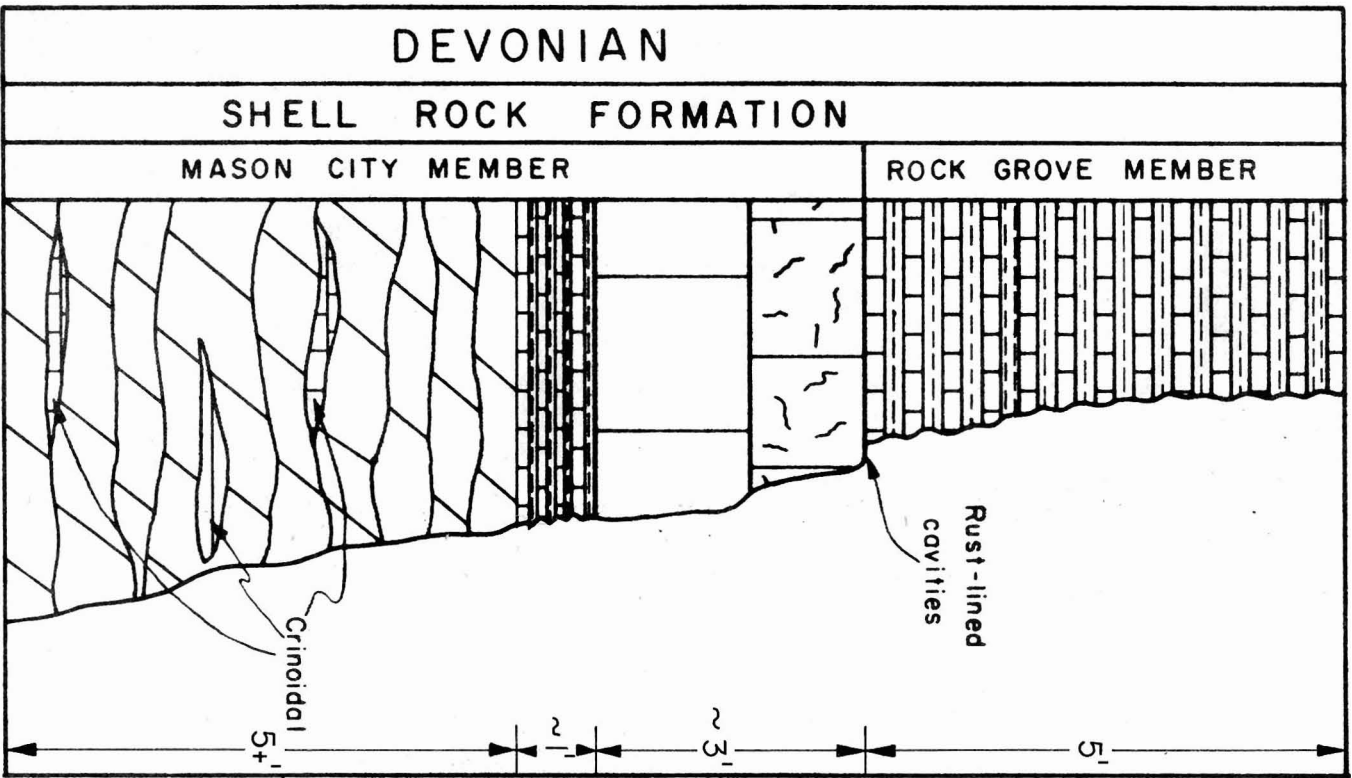


Fig. 32. Section at Dam in Nora Springs

limestone and gray shale at the top of the exposure in the river belong to the lower part of the Rock Grove Member. The top of the underlying Mason City Member is marked by rust-lined cavities, which are particularly well-displayed in a small pit near the parking lot. Corals, brachiopods, stromatoporoids and crinoid stems occur in the formation. In some layers, particularly in the Mason City Member, the rock is packed with broken crinoid stems.

Route to the next stop: Return to U. S. Highway 18 and turn east. In about three-tenths of a mile turn southeast (right) on Rock Grove Road. Continue along this road about one-half mile across a creek to Stop 2, an abandoned quarry on the right side of the road.

Stop 2. Quarry on Rock Grove Road, Nora Springs, Floyd County. The Nora and Rock Grove Members (upper and middle, respectively) of the Shell Rock Formation are exposed here [NE 1/4, Sec. 17, T. 96 N., R. 18 W., Floyd County]. Near the top of the quarry are two massive, five-foot beds of hard white limestone, containing stromatoporoids and brachiopods, separated by an equal thickness of shale which weathers to a gritty yellow clay. This is the Nora Member. The dolomites and shales beneath the lower what stromatopor-

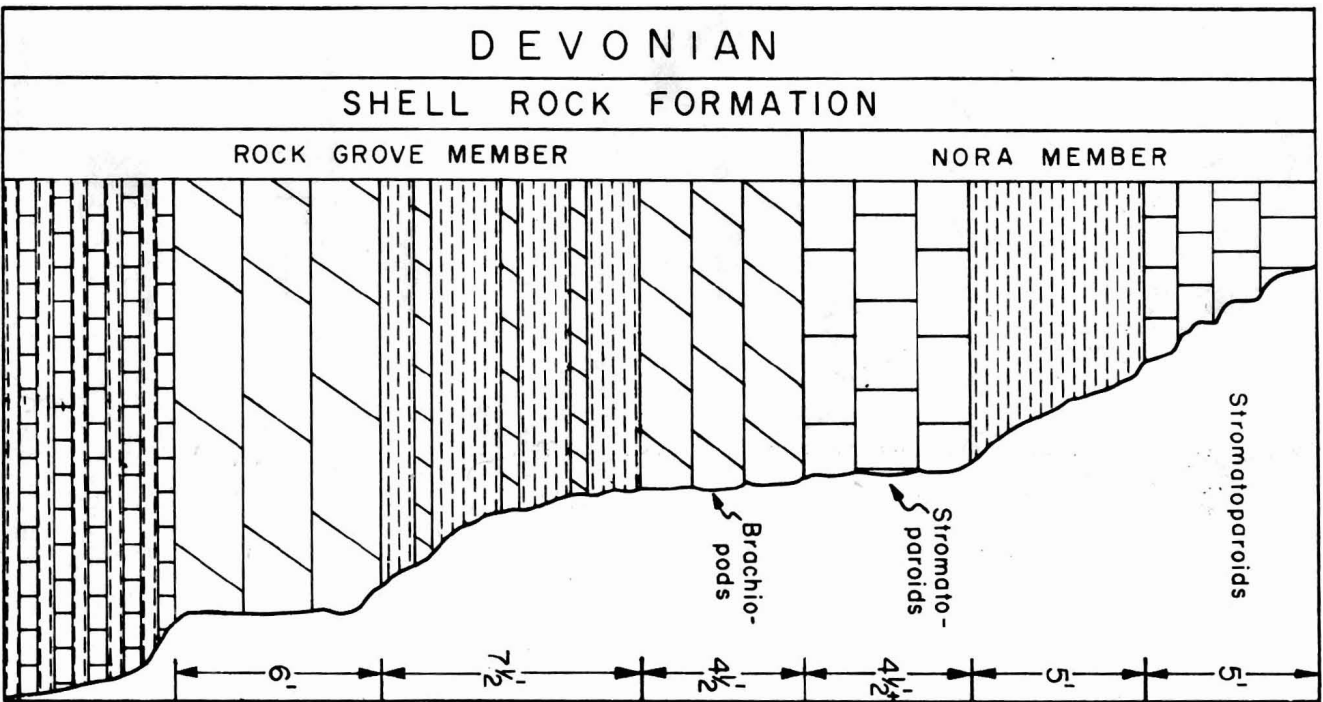


Fig. 33. Section at Quarry East of Nora Springs

oid layer belong to the Rock Grove Member (see Fig. 33). In the creek bed are the thin shales and limestones (visible with difficulty) that were at the top of the section at Stop 1. Brachiopods may be found as casts in the upper part of the Rock Grove Member.

Route to the next stop: Return to U. S. Highway 18 and turn east; continue to the intersection with State Highway 147 (about three miles). Turn south on Highway 147 to Rockford, and turn south and west on County Road D at the west edge of Rockford (see Fig. 31). Follow signs to the Rockford Brick and Tile Company; the clay pit of this company is Stop 3, and a roadcut known as Bird Hill, about one and a quarter miles farther west and south on County Road D, is Stop 4. These two stops will be discussed together.

Stops 3 and 4. West and South of Rockford, Floyd and Cerro Gordo counties. These localities [Near Center of NE 1/4, NW 1/4, Sec. 16, T. 95 N., R. 18 W., Floyd County, and Center of N line, Sec. 24, T. 95 N., R. 19 W., Cerro Gordo County] represent one of Iowa's most famous collecting sites. Here the Cerro Gordo (middle) Member of the Lime Creek Formation of Upper Devonian age carries an unusually



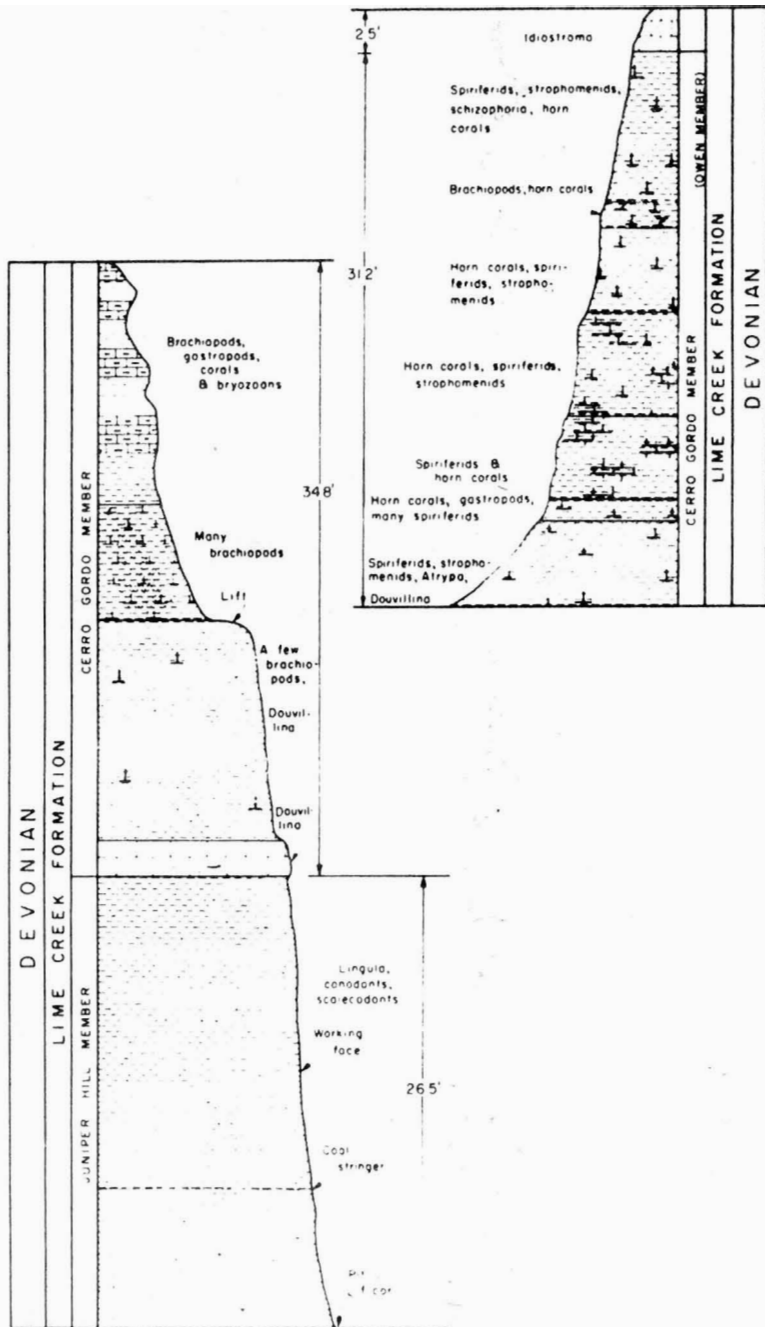


Fig. 34. Composite Section at Rockford and Bird Hill

abundant fauna of brachiopods and bryozoans as well as corals, pelecypods, gastropods and crinoid stems. At the Rockford Brick and Tile Company pit (Stop 3), the Juniper Hill (lowest) Member of the Lime Creek Formation is present, and is the source of the clay shales used in tile manufacturing. The lowermost two feet of the dolomitic Owen (upper) Member of the formation may be seen at the top of the roadcut at Bird Hill (Stop 4).

A distinct contrast is present in the faunas of these three members of the Lime Creek Formation. The animals found in the same area changed, not only with time (as a comparatively short time interval is involved), but also with the sedimentary environment, which exerted the stronger control in this case.

The blue-black muds that formed the thinly laminated, plastic clay shales of the Juniper Hill Member contained only a few inarticulate brachiopods, some sponges, and the microscopic, phosphatic conodonts. The latter are probably parts of pelagic (floating) organisms, and would not have been affected by the nature of the sea-bottom environment, which was probably inhospitable to most forms of animal life. Similar types of fossils (although different genera and species) are found in other Paleozoic black shales in

many parts of the country.

In contrast, the Cerro Gordo Member, with its alternating calcareous shales and muddy limestones is, at this locality one of the most richly fossiliferous in the state. To the west the unit has been dolomitized, and contains fewer fossils. Clearly there was at this time an environment unusually favorable to marine animals, particularly brachiopods, bryozoans, gastropods and pelecypods. Corals and crinoids must have been moderately abundant, although only the stems of the latter are generally found. This association is a common one in the Paleozoic rocks, and is thought to represent fairly shallow seas with a moderate amount of mud on the bottom, but with an abundant supply of nutrients and oxygen. In part, the apparent abundance of the fauna may reflect conditions of preservation which allowed an unusually large percentage of the organisms to be fossilized. However, the variety of forms displayed within single species of brachiopods, and the possibility that some of these organisms show old-age forms suggests a peculiarly favorable environment.

Many of the fossils of the Cerro Gordo Member, particularly the brachiopods, have other organisms attached to them, presumably in growth position. Other brachiopods, of the

inarticulate type particularly, bryozoans, snails, and minute colonial tabulate corals are among the commonest forms attached to other shells. Of course, it is impossible to tell in most cases whether the relationship was one of parasitism, commensalism or symbiosis. Probably the bulk of the forms we find are only commensals, as they are external, have a protective shell of their own, and do not appear to have penetrated the shell of the host. Groove-like markings, however, on the surfaces of some brachiopods are interpreted as having been made by a boring sponge ("Cliona hackberryensis"). The organism which produced the grooves has never been positively identified among the many remains in the Cerro Gordo.

In the limestones and dolomites of the Owen Member, corals and stromatoporoids dominate the fauna. It is thought that the sea at this time was shallower and clearer than before -- an environment conducive to the growth of corals (and probably to that of the extinct stromatoporoids), and one associated with the formation of many limestones.

The richness and variety of the Cerro Gordo fauna has permitted the subdivision of the Member into three zones and numerous zonules or faunules. However, since the Cerro Gordo Member is stripped away at the Rockford pit to expose

the Juniper Hill shales, the stratigraphic sequence is destroyed. Road grading may have covered or disturbed some of the section at Bird Hill, and great care should be taken to dig through the slumped and surficial materials to a fresh face if you desire to sample stratigraphically. In general, the Rockford pit exposes the lower and middle parts of the Cerro Gordo Member and Bird Hill exposes the middle and upper parts (see Fig. 34). The topmost thin ledge (about a foot and a half to two feet thick) at Bird Hill is the Owen Member, and contains the small branching stromatoporoid Idiostroma.

Route to the next stop: continue west on County Road D about two and a half miles. Proceed ahead (west) on an unmarked paved road (County D turned north at this point) which later becomes gravel. Follow this road about six miles to the intersection with U. S. Highway 65. Turn south on Highway 65 and continue about four miles to the town of Rockwell and Stop 5 in the City Park.

Stop 5. City Park, Rockwell, Cerro Gordo County. The remaining upper part of the Owen Member of the Lime Creek Formation may be seen here [SE 1/4, SW 1/4, Sec. 3, T. 94 N., R. 20 W., Cerro Gordo County]. Corals and stromatopo-

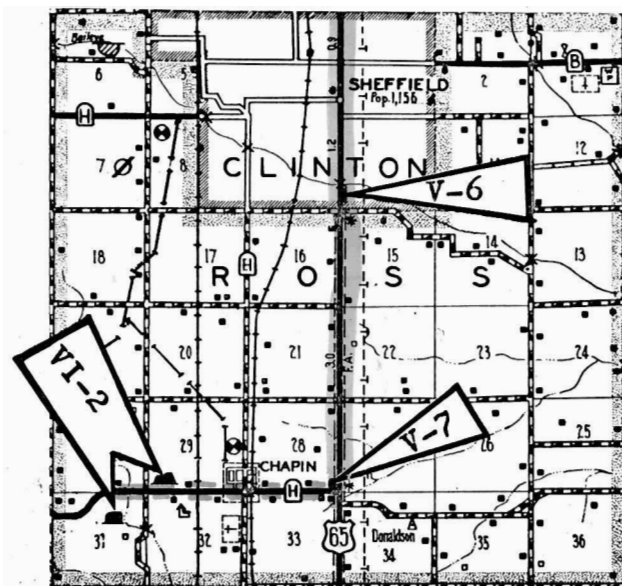


Fig. 35. Map of Sheffield-Chapin Area

roids are abundant, and the latter may form reef-like structures.

Route to the next stop: Continue south on U. S. Highway 65 about seven and a half miles, through the town of Sheffield to a roadcut near the south city limits for Stop 6 (see Fig. 35).

Stop 6. Sheffield, Franklin County. In a roadcut between a small creek and the southern town limits [Near SW Corner, Sec. 10, T. 93 N., R. 20 W., Franklin County] is exposed about 20 feet of the Sheffield Formation. This blue-gray shale is overlain by about twelve feet of the brown, cherty, fossiliferous Aplington Dolomite. The age of these two formations has been the subject of much debate, some authorities calling them uppermost Devonian, and others claiming they were lowermost Mississippian (Kinderhook). Recent studies on conodonts indicate an Upper Devonian age for both formations. These units overlie the Lime Creek Formation.

Route to the next stop: Continue south on U. S. Highway 65 about three miles to the intersection with County Road H. for Stop 7.

Stop 7. Near Chapin, Franklin County. At this locality [SW Corner, Sec. 28, T. 93 N., R. 20 W., Franklin County] there is an exposure of the Aplington Formation of uppermost Devonian age for Iowa. This dolomite contains the "white shells" -- silicified brachiopods such as Cleiothyridina humerosa and Camarotoechia contracta and various spiriferids. Crystal-lined cavities -- generally of calcite -- are common in the lower part of the formation, and a few good quartz geodes may be available.

About two miles to the west on County Road H is the type locality of the Chapin Member of the Hampton Formation, of Kinderhook (Lower Mississippian) age, which will be seen at Stop 2 of Trip VI.

This is the last suggested stop of Trip V. An attempt has been made to show the sequence of Upper Devonian formations, the richness of the Upper Devonian fossil record, and to introduce some of the problems associated with the Mississippian-Devonian boundary.



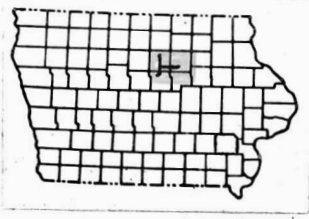
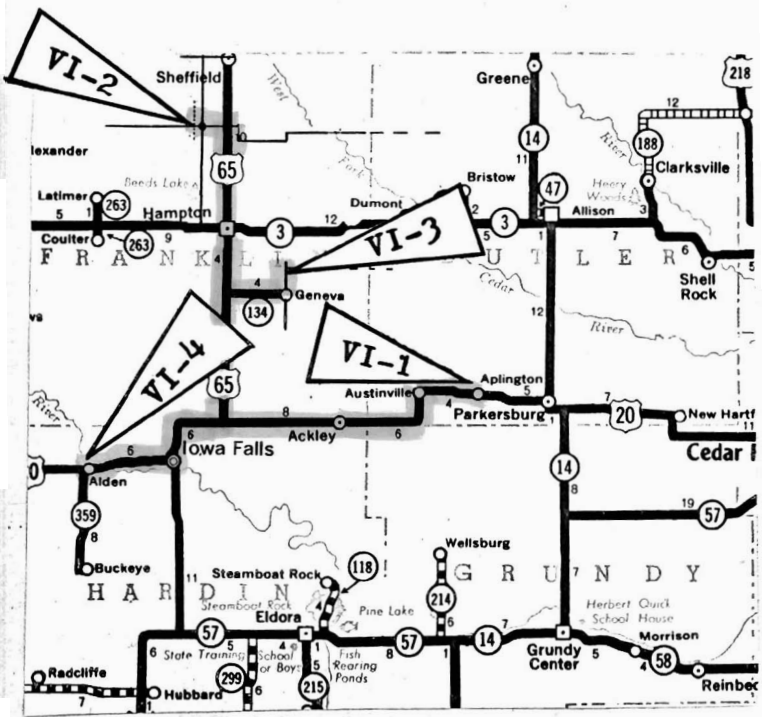


Fig. 36. Trip VI Route Map

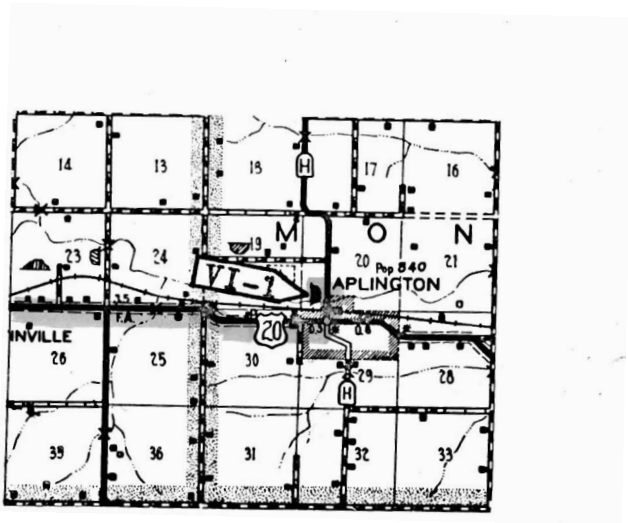


Fig. 37. Map of Aplington Area

TRIP VI

## LOWER MISSISSIPPIAN ( KINDERHOOK)

## North-Central Iowa

The town of Aplington, on U. S. Highway 20 in Butler County is suggested as an assembly point. The four suggested stops on this trip (see Fig. 36) will require a half day.

To get to the first stop, go north on County Road H out of Aplington (the road by the old bank building) about one-half mile, crossing the railroad tracks. Stop 1 is an abandoned quarry on the west side of the road. There is some derelict machinery in the quarry, so that caution is urged if cars are taken in. The old quarry is being used partly as dump and partly as cow pasture.

Stop 1. North of Aplington, Butler County. This quarry [W 1/2, Sec. 20, T. 90 N., R. 17 W., Butler County] is the type section of the Aplington Formation, as set up by M. L. Stainbrook (1950), to serve as the standard reference for comparison for this formation. As with all too many type sections, the quarry in which it was described has been abandoned and is now used for other purposes. Most of the

original face can still be seen here, however.

The rather soft, yellow dolomites carry a fairly abundant brachiopod fauna, among which are Camarotoechia contracta and Cleiothyridina humerosa, as well as various productids. The brachiopods have been partly or wholly silicified, and these "white shells" present a striking contrast to the yellow and yellow-brown dolomites. In many cases, the replacement process has destroyed much of the detail of the shells, so that precise identification is difficult.

Stainbrook's original description of the formation is presented below, as an example of a description of a type locality.

In a number of localities the basal member of the Aplington is a hard limestone almost completely composed of shells and shell fragments and approaching a coquina in lithology. The beds vary in thickness from two to ten feet and are generally massive although weathering into thin irregular layers. In several places a two foot bed of shale intervenes between the limestone and the upper dolomite member but elsewhere the dolomite may lie directly on the limestone...

The type section is situated about a half mile directly north of Aplington, Butler County, on the west side of the road. Quarry operations have been extensive and a considerable area is at present (1947) uncovered. All members are available except the basal limestone which does not occur here. The Sheffield shale was formerly

visible but the pit exposing it is now filled in. The section given below may not be completely available to observers in the future.

Type section of the Aplington Formation,  
Aplington, Iowa

Aplington	Feet
7. Dolomite, soft, yellow, thin-layered, a crinoidal zone near base.	4 - 5
6. Dolomite, yellow, soft, fossiliferous, <u>Camarotoechia</u> , <u>Spirifer</u> , <u>Arctospirifer</u> , <u>Schellwienella</u> , <u>Cleiothyridina</u> , and productids.	3
5. Dolomite, yellow, soft, capped by a cherty layer, 1-3 in. thick in middle portion. (Large productid zone).	3
4. Dolomite, yellow, softer than that below, chert at top, numerous small productids and a small form of <u>Cleiothyridina</u> near top. (Small productid zone.)	4
3. Dolomite, soft, yellow, carrying numerous <u>Spirifers</u> with white shells, in three heavy beds. ( <u>Spirifer</u> zone.)	4
2. Dolomite, massive, dark yellow brown, tough, many holes, fossils abundant, white, weathering with hollow shells, <u>Cleiothyridina</u> , <u>Spirifer</u> , large productids as molds, <u>Schellwienella</u> . ( <u>Cleiothyridina</u> zone.)	3
1. Dolomite, massive, yellow-brown with reddish phases, especially at bottom, carrying small geodes, hollow, numerous fossil molds.	3 - 4

### Sheffield shale

Shale, yellowish where weathered, blue elsewhere, exposed for three or four feet.

Some of the small geodes (or, more properly, vugs) of Bed 1 can be seen in blocks lying on the old quarry floor. Some of the cavity linings are brightly colored.

It is an interesting exercise to attempt to recognize all the beds and zones of this original description in the type locality.

Stainbrook believed that the Aplington Formation was of Kinderhook (Lower Mississippian) age. Other authorities thought the formation was Upper Devonian. The latter view has been supported by recent work on the conodonts of the formation.

Route to the next stop: Return to U. S. Highway 20 and go west about 19 miles to the junction with U. S. Highway 65. Turn north on Highway 65 and continue about 19 miles to the intersection with County Road H east of Chapin. Turn west towards Chapin (see 35); cross two sets of railroad tracks on the east and west sides of the town. About a half mile beyond the western set of railroad tracks is an intersection

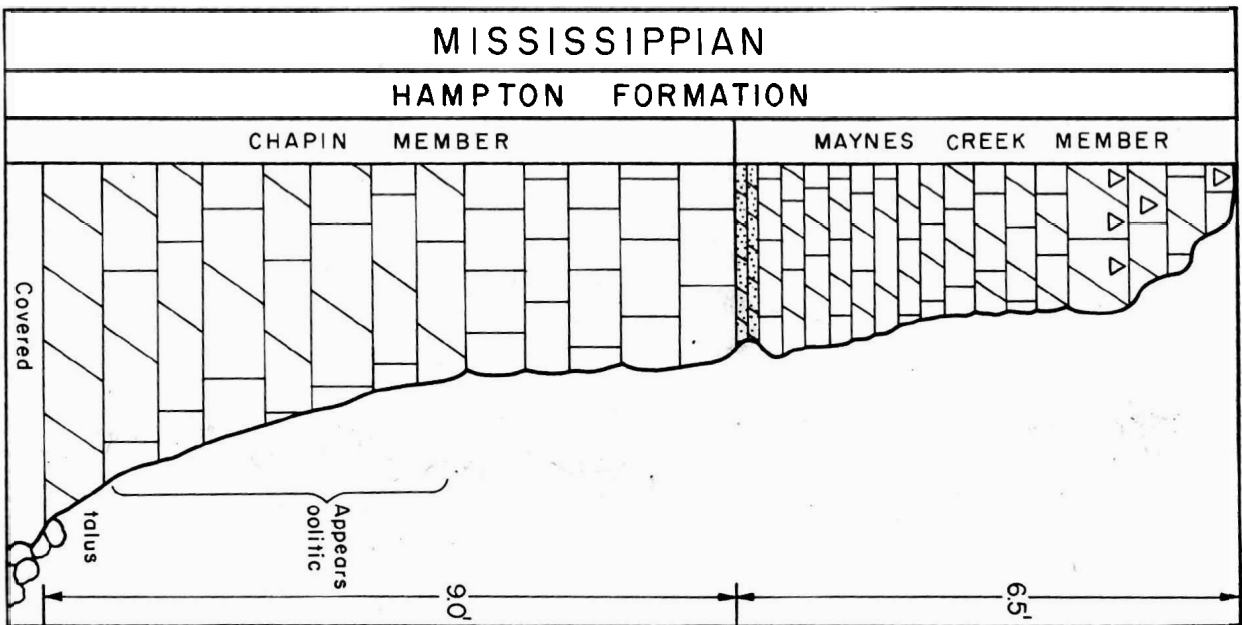


Fig. 38. Section at Chapin

with a north-south gravel road. Quarries on the northeast and southwest corners of this intersection constitute Stop 2.

Stop 2. West of Chapin, Franklin County. These two quarries [SW 1/4, SW 1/4, Sec. 29, T. 93 N., R. 20 W., and NE 1/4, NE 1/4, Sec. 31, T. 93 N., R. 20 W., Franklin County] display the two lower members of the Hampton Formation of north-central Iowa (the Chapin and Maynes Creek Members, in ascending order). These are equivalent to the North Hill and Wassonville Members, respectively, of the same formation in southeastern Iowa. These two members were originally set up as separate formations; this was the type locality for the old Chapin Formation, and remains the type locality for the member.

The upper six feet, which are dolomites (soft, thin-bedded and yellowish at the top, dark brown and harder in the middle, with a half-foot thick layer of soft dolomite sand at the base) make up part of the Maynes Creek Member; the remaining limestones and basal dolomite constitute the Chapin Member (see Fig. 38). Both Members are fossiliferous, and the middle beds of the Chapin Member contain worn crinoid fragments that give it an oolitic appearance. True oolites may be found in this member in southeastern Iowa.



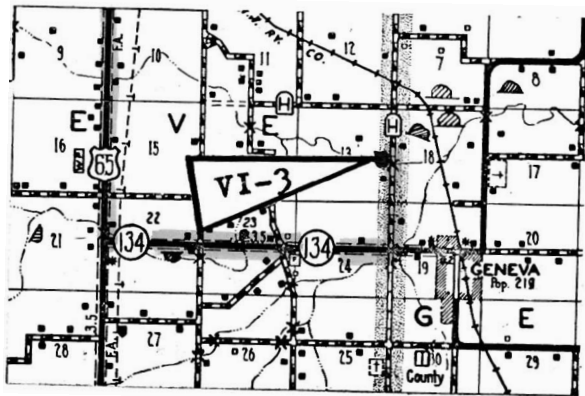


Fig. 39. Map of Geneva Area

Among the commonest fossils in the Chapin Member are the small, slender, curved solitary rugose coral Cyathaxonia arcuata and the flat brachiopod Rhipidomella tenuicostata. Other brachiopods, corals, and crinoids are known from these members, as well as rare blastoids.

Route to the next stop: Return to U. S. Highway 65 and turn south; continue to the intersection with State Highway 134 and bear east towards Geneva. Note to the west of Highway 65 the badly overgrown type section of the Maynes Creek Member, located about 800 feet up Maynes Creek, on a pony farm. Three miles east along State Highway 134 turn north on County Road H and continue about one mile to a quarry on the west (left) side of the road, for Stop 3 (see Fig. 39).

Stop 3. Phillips Quarry, Geneva, Franklin County. At this quarry [SE 1/4, NE 1/4, Sec. 13, T. 91 N., R. 20 W., Franklin County] the Eagle City Member of the Hampton Formation can be seen overlying the Maynes Creek Member (see Fig. 40). The upper nine feet of limestone are placed in the Eagle City Member, and the remaining dolomitic limestones are put in the Maynes Creek Member. In the Eagle City Member there are a few spiriferid brachiopods and other

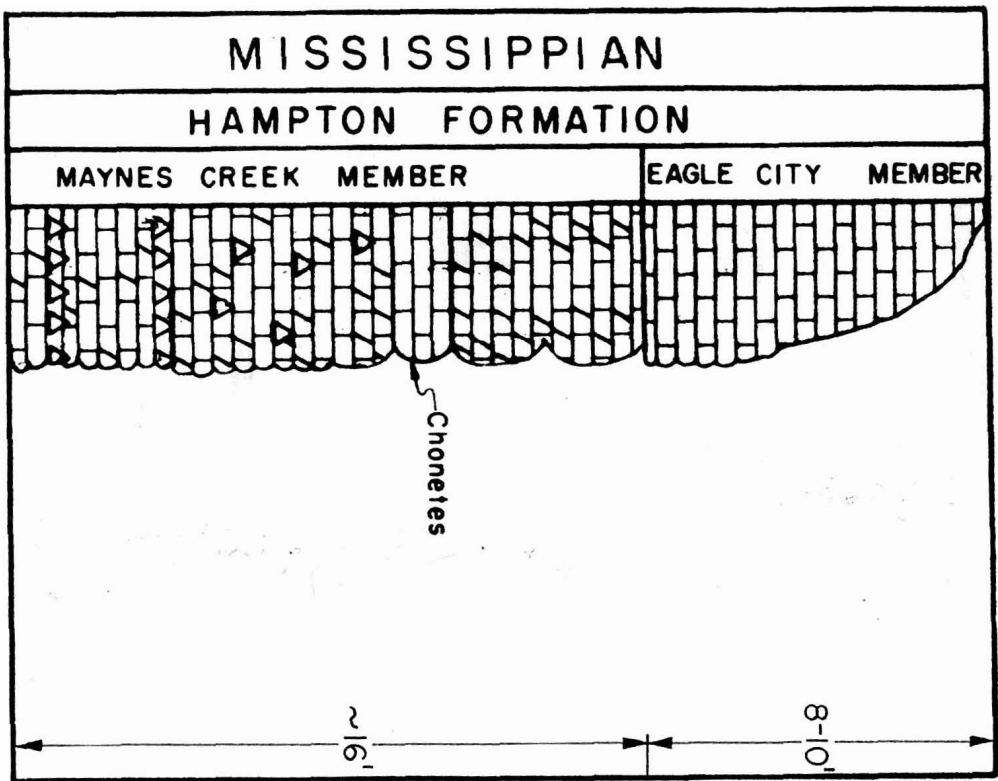


Fig. 40. Section at Phillips Quarry, Geneva

brachiopod fragments, perhaps some rare crinoids with abundant crinoidal fragments. The Maynes Creek carries Chonetes and other brachiopods, and is cherty.

Across the road is another quarry, displaying only the Maynes Creek Member.

Route to the next stop: Return via State Highway 134 to U. S. Highway 65 and bear south. Continue along Highway 65 which merges with U. S. Highway 20 after about nine miles, to the town of Iowa Falls. Note that exposures along the Iowa River in and about Iowa Falls constitute the type section of the Iowa Falls Member of the Hampton Formation, which in part overlies and in part is equivalent to the Eagle City Member. Bear west on U. S. Highway 20 out of Iowa Falls to the town of Alden (see Fig. 41). The Iowa Limestone Company Quarry, on the north side of the Iowa River, can be reached by going into downtown Alden, crossing the Iowa River Bridge on County Road B and turning right. This is Stop 4.

Stop 4. Iowa Limestone Company Quarry, Alden, Hardin County. The 40 to 45 feet of rather oolitic limestones exposed in this quarry [SW 1/4, NE 1/4, Sec. 18, T. 89 N.,

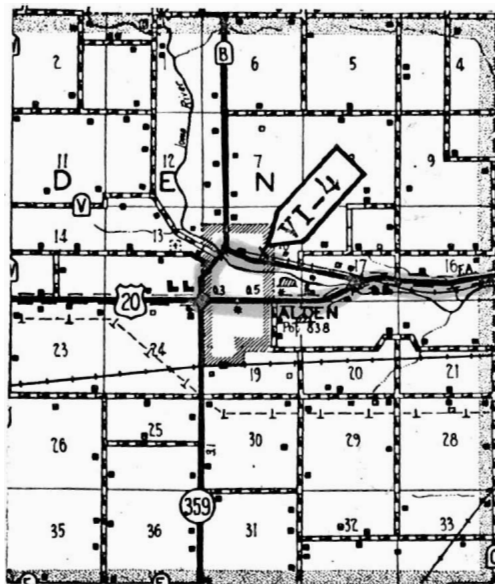


Fig. 41. Map of Alden Area

R. 21 W., Hardin County] once constituted the type section of the "Alden Formation". It has since been shown that the "Alden Formation" is, in fact, the same unit as the Gilmore City Formation, so that this area is no longer a valid type section, and the formation has no formal status. The Gilmore City Formation in this area appears almost the same as in the type area to the west, at Gilmore City. Bedding is rather irregular, and some "false" cross-bedding may be displayed; the latter reflects changes in the rock after, rather than during deposition.

Many of the very small round particles which have been called "oölites" here prove, upon microscopic examination, to be small, rounded fragments of shells or calcite, without the radially concentric structures that "true" oölites show.

Some corals and crinoids occur in the quarry, but they are not abundant.

This is the last suggested stop. An attempt has been made to point out some problems connected with the age assignments of certain formations in north-central Iowa, and to point out type sections and classic exposures in the area.

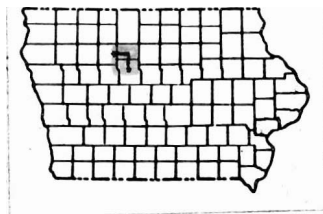
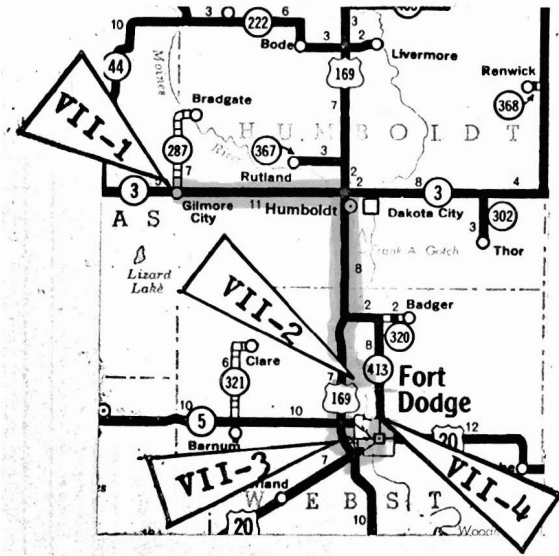


Fig. 42. Trip VII Route Map

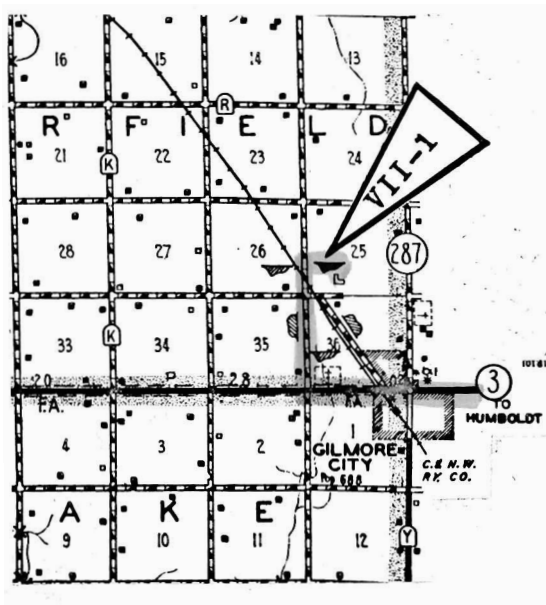


Fig. 43. Map of Gilmore City Area



TRIP VII

## MISSISSIPPIAN

## North-Central Iowa

Assembly is suggested in the town of Gilmore City, Pocahontas County; the town is on the Pocahontas-Humboldt County line, at the intersection of State Highways 3 and 287. The four suggested stops of this trip (see Fig. 42) can be covered in half a day, but more time could be allotted for collecting at the last two stops.

To reach the first stop, go west out of town on State Highway 3 to the first north-south gravel road and turn north. Continue a little over one mile, crossing a railroad track. Stop 1 is on the east side of the road, and the offices of the Midwest Limestone Company (permission to enter must be obtained) are on the west side.

Stop 1. Midwest Limestone Company Quarry, Gilmore City, Pocahontas County. There are a number of abandoned and working quarries closely clustered about this area [SW 1/4, Sec. 25, T. 92 N., R. 31 W., Pocahontas County]. The first large abandoned pit on the north side of the entrance drive (see Fig. 43) is the type section of the Gilmore City

Limestone, and provides the best fossil collecting. When this section was described, about 58 feet of the Gilmore City Limestone was exposed in the pit; the bottom of the formation was not exposed even then, and the full thickness is seen only in well cores. The lower beds of this original section are now under water permanently, and the lower brachiopod and crinoid zones may also be covered during especially rainy seasons. (see Fig. 44). In the upper 14 feet of thin-bedded, oolitic gray limestone, green shales may be seen filling cracks and crevices.

"Cyathophyllum"-like solitary rugose corals may be found here in moderate numbers. In the 18 feet of massive, gray limestone just below, most of the fossils are broken and fragmented; they are more abundant near the base, and include corals, brachiopods, gastropods, echinoid spines and very rare crinoids. The next eight feet of gray to greenish limestones and shales are very fossiliferous, and constitute the "Rhodocrinites Zone", from which a number of crinoids have been collected in the past. The crinoids occur in "nests" or "colonies"; they are common within the "nest" and very scarce between "nests". Several species of Rhodocrinites and Dichoerinus and the large Cactocrinus imperator may still be found with diligent searching.

Eumetria verneuilliana is the commonest brachiopod in this

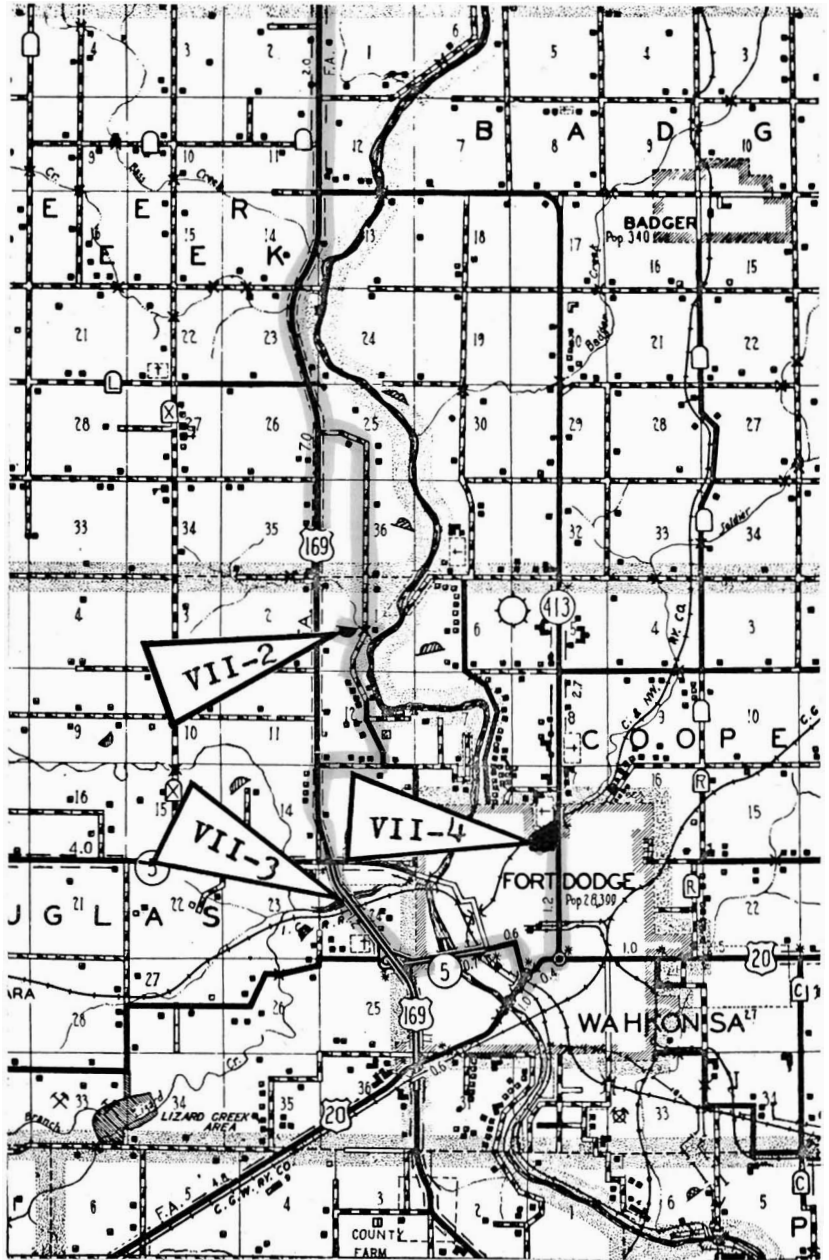


Fig. 45. Map of Fort Dodge Area

zone. Below the "Rhodocrinites Zone" occurs about three feet of soft, shaly, bluish-green dolomites which are also very fossiliferous; this is the "Rhynchopor Zone", named after the abundant brachiopod Rhynchopora cooperensis. A species of Spirifer is also common in these beds. This zone and the one above it are periodically submerged; the remaining 15 feet of the original section is almost constantly under water.

The Gilmore City Limestone is generally considered to be of uppermost Kinderhook (uppermost Lower Mississippian) age. In this area, the formations of the Osage (lower of the two middle Mississippian series) are absent, and the Gilmore City is commonly overlain by the St. Louis Limestone of the Meramec (upper of the two middle Mississippian series).

Route to the next stop: Return to State Highway 3 and turn east. Continue about twelve miles to Humboldt and the intersection with U. S. Highway 169. Turn south on Highway 169 towards Fort Dodge, and continue about ten and a half miles. Here a gravel road bears east (left). Follow it about one-half mile east and then two miles south to the quarry of the Northwest Limestone Company for Stop 2. (see Fig. 45). Be sure to stop for permission at the quarry office.

Stop 2. Northwest Limestone Company Quarry, Ft. Dodge,  
Webster County. About 18 feet of the Stl Louis Limestone  
is exposed in this quarry [West of Center, Sec. 1, T. 89  
N., R. 29 W., Webster County]. This formation, of Meramec  
age, is generally poorly fossiliferous, and is commonly  
brecciated in some horizons. Here some oblitic limestone  
and some dolomite are present in the formation, and pyrite  
and varigated chert may be collected.

Route to the next stop: Continue south along the same  
gravel road, which becomes paved in about one mile, a total  
of about one and a half miles, to a T-junction. Turn west  
here, along a gravel road, and continue about three-  
quarters of a mile to U. S. Highway 169. Go south on  
Highway 169 about one and a half miles to the bridge over  
Lizard Creek for Stop 3. (See Fig. 45)

Stop 3. Lizard Creek Crossing, Ft. Dodge, Webster County.  
Both upstream and downstream from the Highway, along Lizard  
Creek in Sections 23 and 24, T. 89 N., R. 29 W., Webster  
County, may be seen the Ste. Genevieve Limestone -- here  
composed largely of calcareous shales, despite its name --  
underlain by the St. Louis Limestone and overlain by  
Pennsylvanian shales and sandstones and Cretaceous (?)

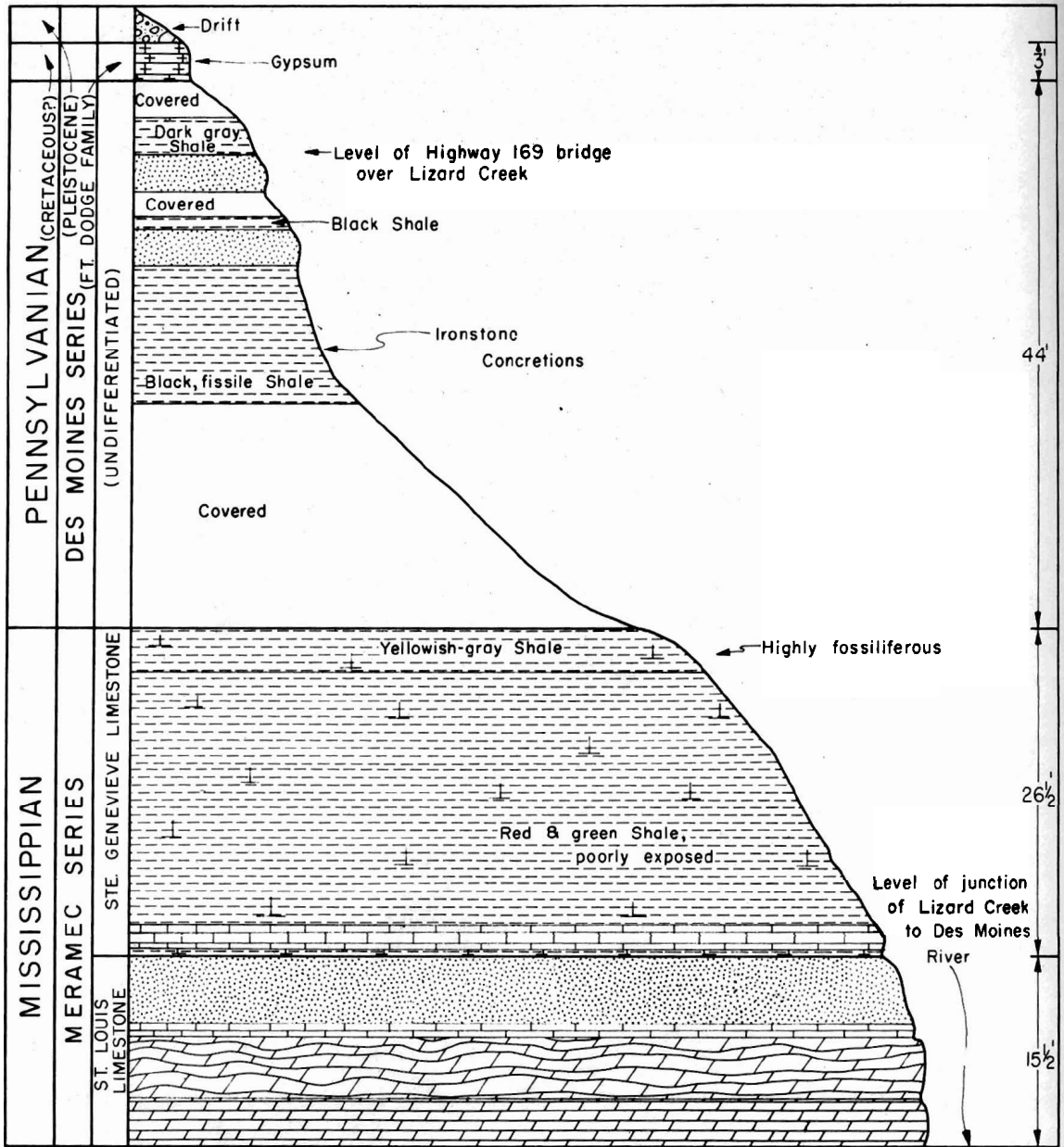


Fig. 46. Section at Lizard Creek Crossing

gypsum. The Ft. Dodge Limestone Company mine is upstream, but visits to the mine are not encouraged.

A maximum of 15 1/2 feet of St. Louis Limestone (sandstone at the top, with limestone and sandy dolomite below) lies between the Ste. Genevieve and the creek bed. The Ste. Genevieve is about 26 feet thick, with the most fossiliferous shales at the top. Above a covered interval of about 18 feet lie some 15 feet of Pennsylvanian black shales with some gray sandstone near the top. Above a short (two-foot) covered interval are three feet of sandstone and three of shale, also Pennsylvanian, and another covered interval (three feet). Above that are about three feet of the Fort Dodge gypsum beds, probably of Cretaceous age.

The fossils of the Ste. Genevieve here are essentially the same as those at Pella and Oskaloosa (the "Pella beds" -- see Trip VIII, Stops 4 and 5). Brachiopods, corals and bryozoans are extremely abundant, and include such forms as Spirifer pellaensis, Pugnoides ottumwa, Composita trinuclea, "Zaphrentis" pellaensis, several species of Productus, Allorisma sp. and fenestellid ("lacey") and encrusting and branching bryozoans.

Route to the next stop: Proceed south along U. S. Highway

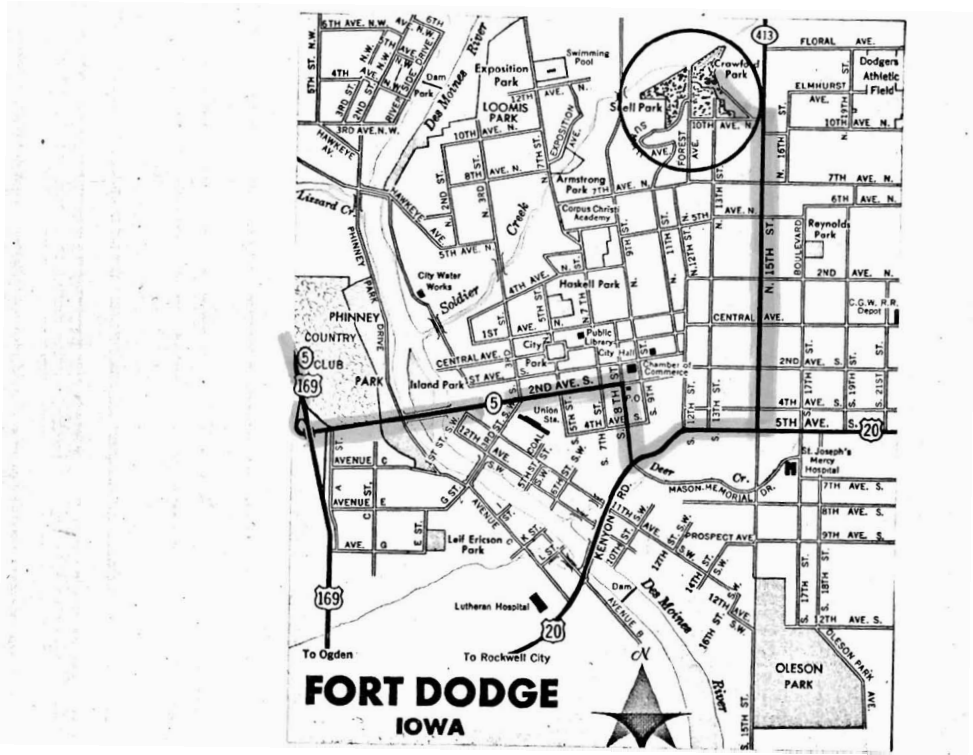


Fig. 47. Fort Dodge City Map



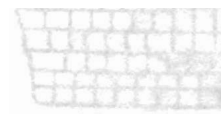
169 a little over half a mile to the intersection with State Highway 5. Go east on Highway 5 across the Des Moines River and sharply south to the intersection with U. S. Highway 20 (see Fig. 47). Jog northeast on Highway 20 to the intersection with State Highway 413 and turn north (State Highway 413 is the same as 15th street). Follow Highway 413/15th Street to Snell-Crawford Park, near the north city limits of Fort Dodge, for Stop 4.

Stop 4. Snell-Crawford Park, Ft. Dodge, Webster County.

Along Soldier Creek in the Park [SE 1/4, Sec. 17, T. 89 N., R. 28 W., Webster County] can be seen exposures of the Fort Dodge gypsum and associated shales. About eight to ten feet of gray gypsum is overlain by bright red shales which are quite distinct from the dark red and black shales of the Pennsylvanian. It is permissible to collect loose pieces from the creek bed, but removal of blocks from the exposures is prohibited.

This is the last scheduled stop. It has been attempted to demonstrate the upper Middle Mississippian formations of north-central Iowa, in order to compare them with formations of the same age in southeastern Iowa. In addition, although this guidebook is not directly concerned with Pennsylvanian

and younger rocks, the relationship between the Mississippian and these younger rocks has been shown. The Fort Dodge gypsum is a rock unit of considerable economic importance, and occurs only in a rather restricted area around Fort Dodge.



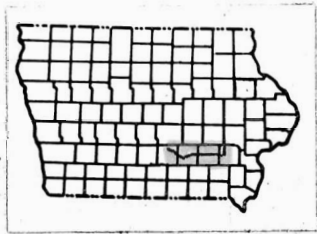
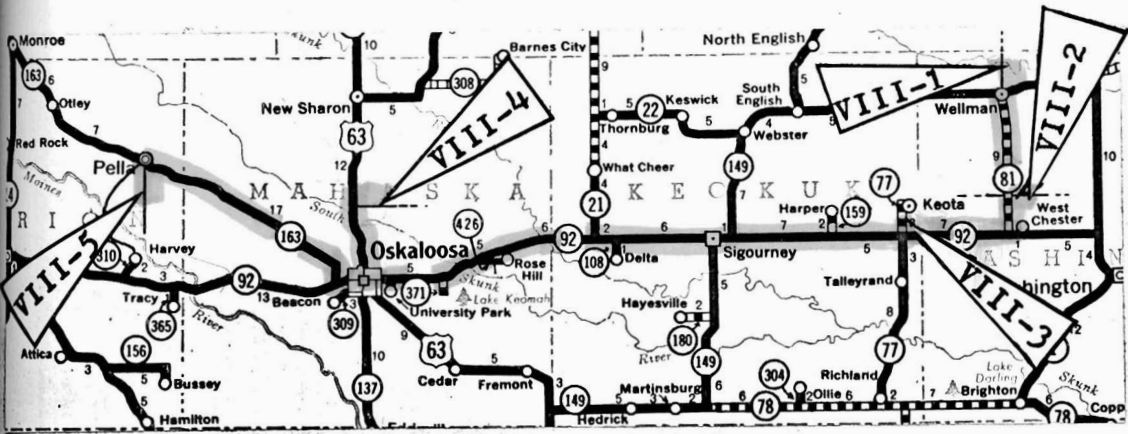


Fig. 48. Trip VIII Route Map

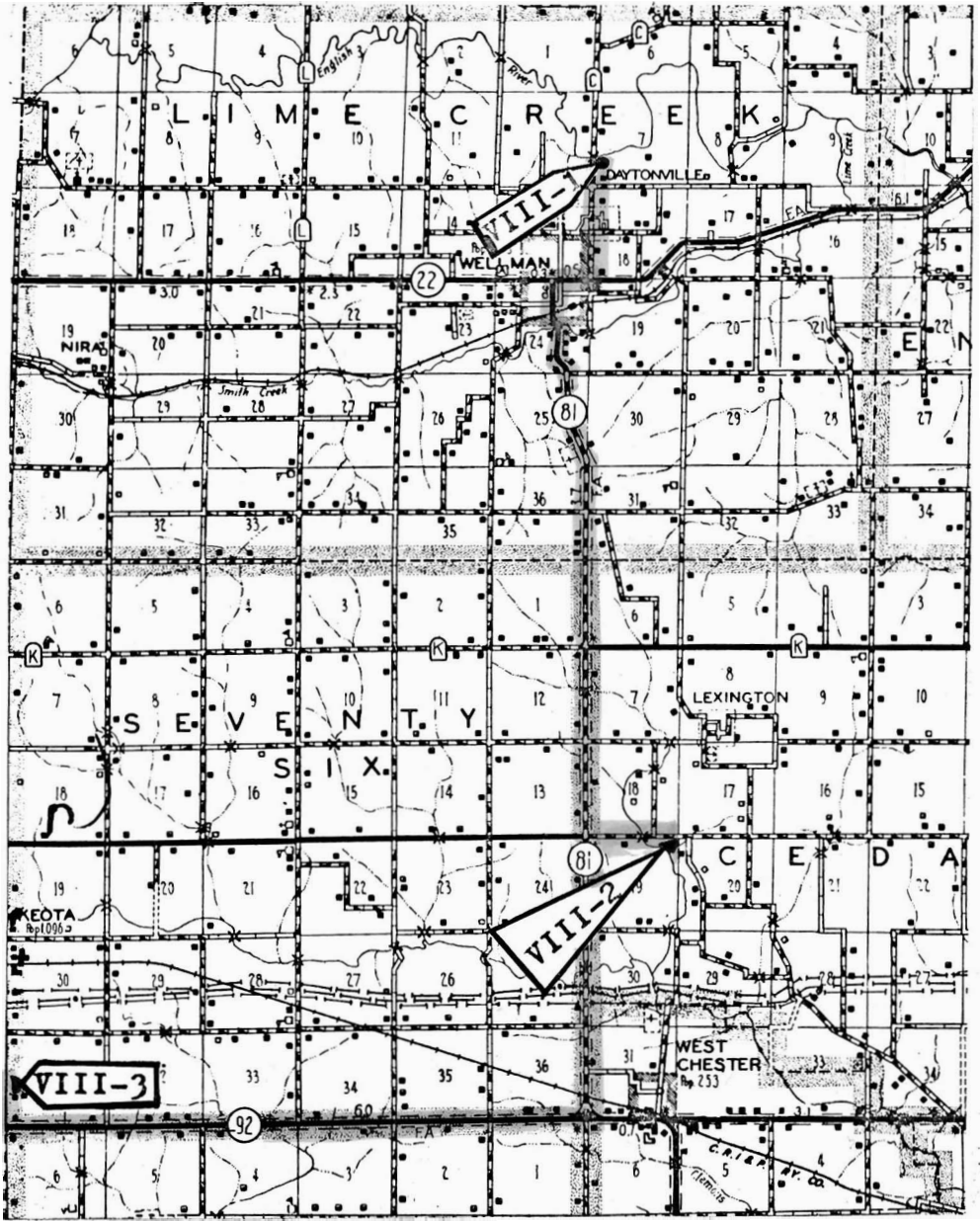


Fig. 49. Map of Wellman-West Chester-Keota Area

## TRIP VIII

### MISSISSIPPIAN

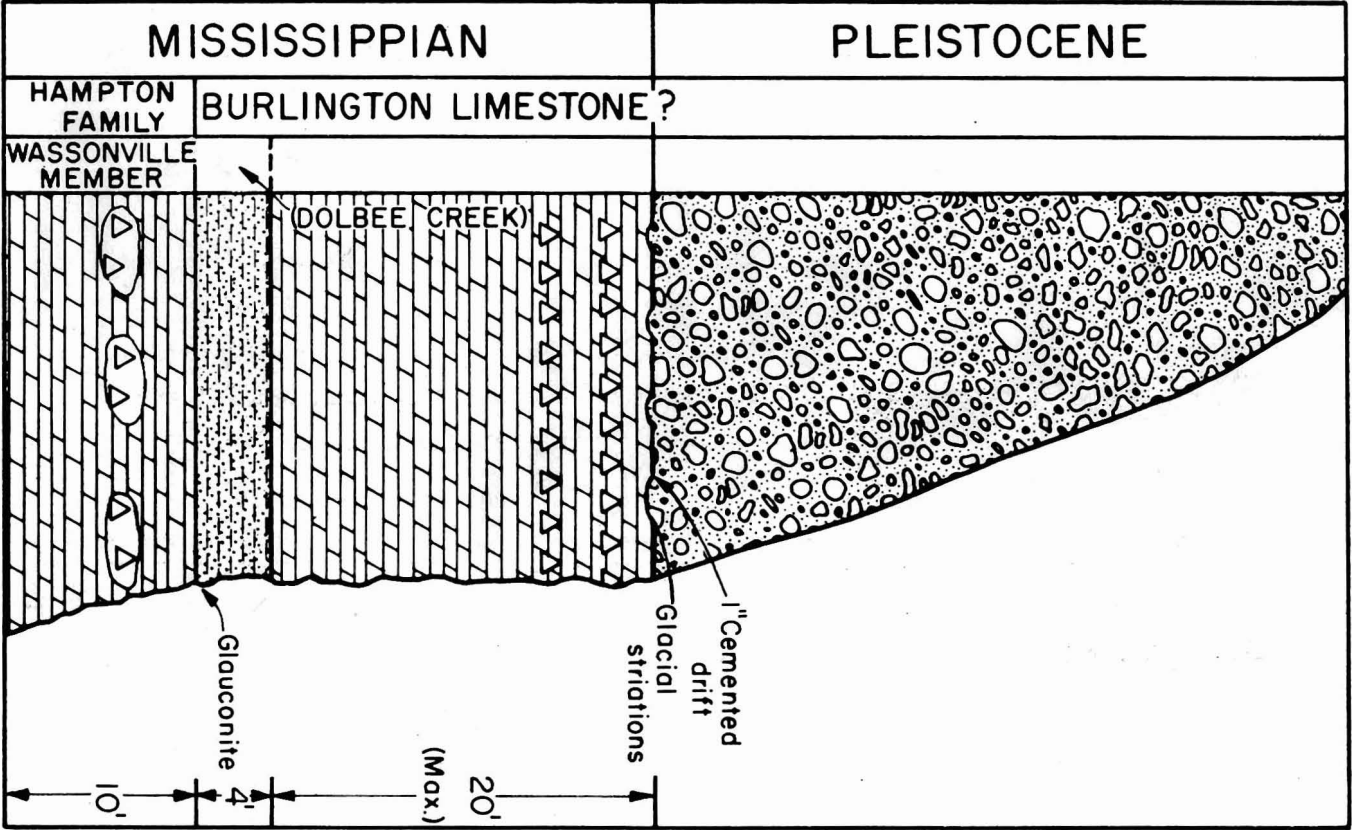
#### Southeastern and South-Central Iowa

Assembly is suggested in the town of Wellman, at the intersection of State Highways 81 and 82, in Washington County. The five suggested stops for the trip (see Fig. 48) will take a whole day to cover.

To get to the first stop, go east through the town on Highway 22 and turn north on County Road C at the eastern town limits. Continue north about one and a quarter miles, passing two gravel cross-roads, to Stop 1, an abandoned quarry on the east (right) side of the road, near the south bank of the English River.

Stop 1. Quarry north of Wellman, Washington County. This old quarry [SW 1/4, Sec. 7, T. 77 N., R. 8 W., Washington County] is across the road from the type section of the Wassonville Member of the Hampton Formation of Kinderhook (Lower Mississippian) age. The member was named for the old Wassonville Mill; the remains of the mill dam may be seen immediately west of the bridge across the English River. The quarry exposes the Wassonville Member, and the lower

Fig. 50. Wassonville Type Section, Wellman



Burlington Limestone appears near the top of the quarry. The contact between the two units is recognized by the appearance of a zone rich in glauconite at the base of the Burlington Limestone. The yellow Wassonville Dolomite contains a number of bands of white, weathered chert (see Fig. 50). Many of these chert layers are richly fossiliferous, particularly in brachiopods and crinoid remains. Among the brachiopods is Chonetes multicostata. The upper chert band contains numerous crinoid fragments, byozoans and the small brachiopod Leptaena analoga.

Route to the next stop: Return to Wellman and turn south on State Highway 81 (see Fig. 49). Continue south about six miles to a cross-roads intersection, the road being paved to the west and gravel to the east. A sign on the corner indicates the West Chester Quarry of the Kaser Construction Company. Turn east (left) and continue about one mile to Stop 2, the Kaser West Chester Quarry.

Stop 2. Kaser's West Chester Quarry, West Chester, Washington County. The Wassonville Member of the Hampton Formation and the Burlington Limestone are exposed in this quarry [NE 1/4, Sec. 19, T. 76 N., R. 8 W., Washington County]. The Wassonville occupies about the lower ten feet of the quarry,

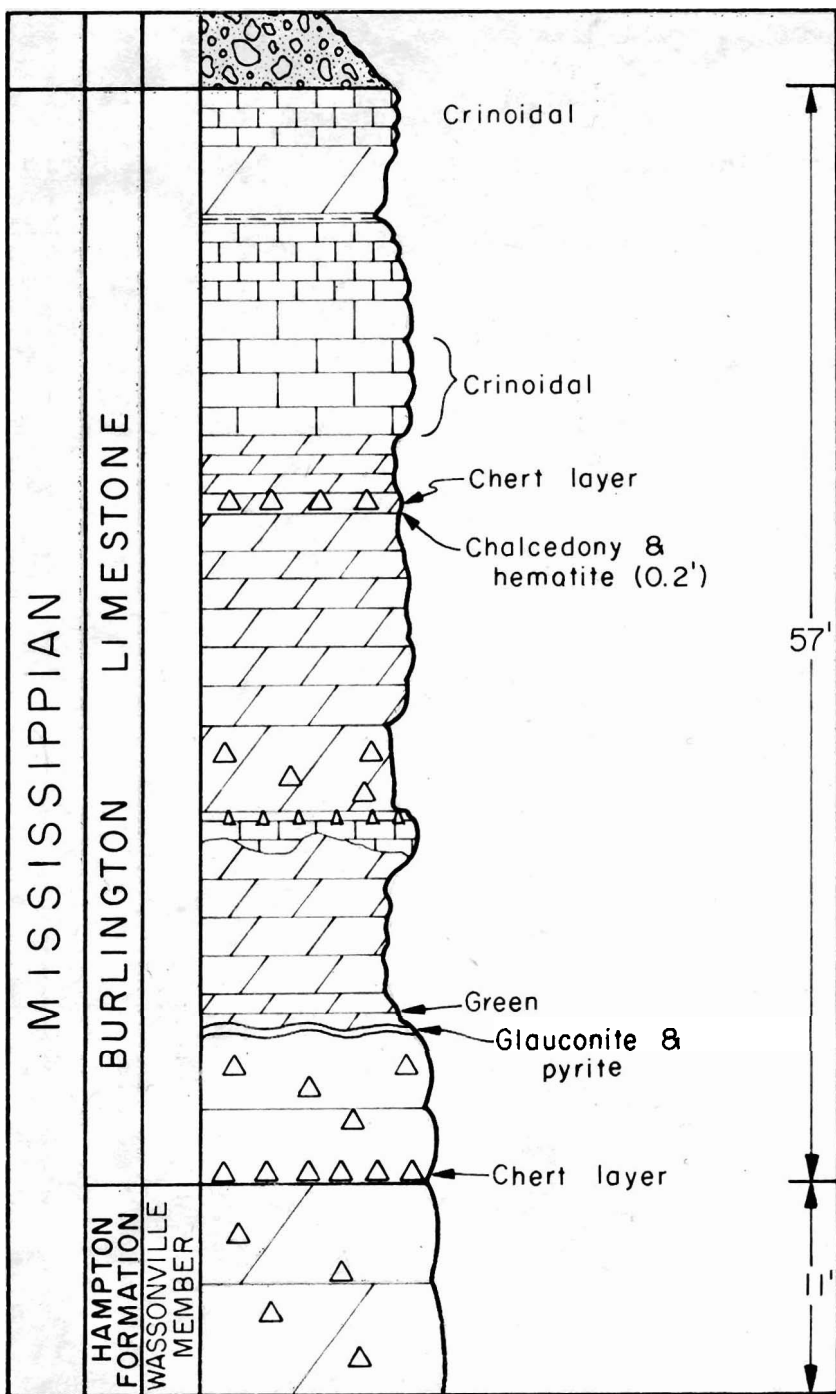


Fig. 51. Section at West Chester



and carries brachiopods, including a form of Chonetes. There is much glauconite throughout the Burlington Limestone, as well as numerous chert bands and nodules. In the upper three feet, there are chalcedony-lined vugs which may be brightly colored. Crinoid stems occur at several levels in the Burlington, forming the bulk of the rock in some zones. The upper three feet is unusually rich in crinoid stems and columnals, and occasional cups have been found there.

Route to the next stop: Return to State Highway 81 and turn south (left). Continue south about three miles to the intersection with State Highway 92. Turn west (right) on Highway 92 and continue about six miles to the intersection with the Washington-Keokuk County Line road (see Fig. 49). Turn north on the county line road and continue a few hundred feet to Stop 3, a quarry on the east side of the road.

Stop 3. Quarry near Keota, Washington County. The Burlington Limestone is exposed in this quarry [Sec. 31, T. 76 N., R. 9 W., Washington County]. Among the fossils available here are very large Spirifer grimesi. Chert may be found in the aggregate piles, and large calcite crystals and cleavage fragments occur in some zones. Good collecting

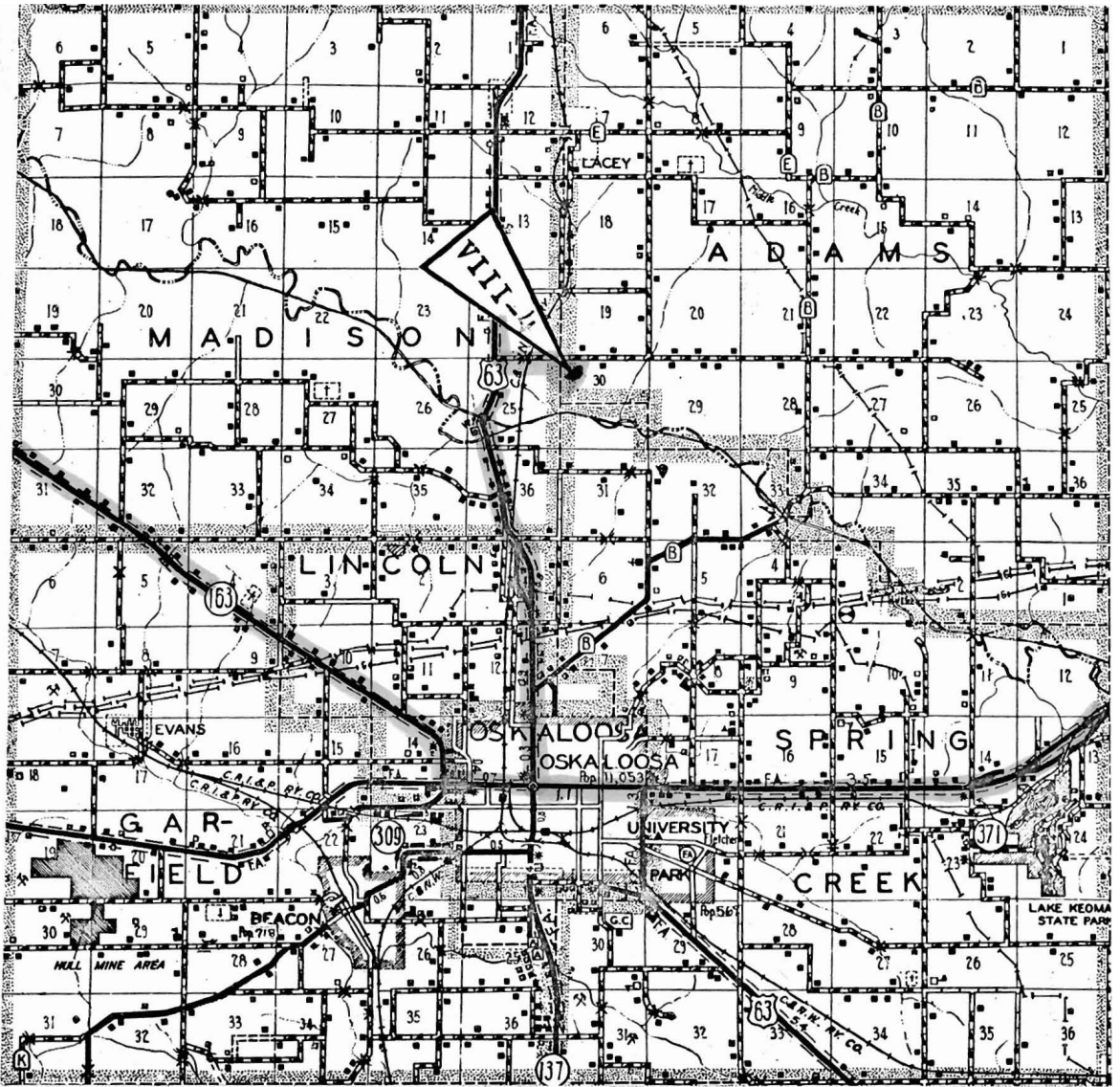


Fig. 52. Map of Oskaloosa Area

is available along the south wall of the quarry. A number of different lithologies may be seen in the Burlington Limestone here, including thin layers of soft shale, dolomite and chert, with occasional oolitic zones.

Route to the next stop: Return to State Highway 92 and turn west (right). Continue along Highway 92 about 38 miles to Oskaloosa. At Oskaloosa, turn north on U. S. Highway 63 and cross the Skunk River (see Fig. 52). Turn east (right) on the first gravel road north of the river. Continue past the railroad tracks to Stop 4, a quarry on the south side of the road.

Stop 4. Oskaloosa Quarry, Mahaska County. At this quarry [Center, Sec. 30, T. 76 N., R. 15 W., Mahaska County] the "Pella Beds", or Ste. Genevieve Limestone, provide excellent collecting, exhibiting a fauna and preservation similar in general aspect to that at Rockford, although much younger. The Pella beds have been correlated with the Ste. Genevieve Limestone of other parts of Iowa and Missouri, and are here overlain by Pennsylvanian shales and sandstones of the Des Moines Series. There is a possibility that shales lying immediately beneath the Pennsylvanian units may represent Mississippian rocks younger than any hitherto



known in the state.

Pella Beds

Fossils occur throughout the exposure; the aggregate piles provide particularly easy collecting. Many brachiopods such as Spirifer pellaensis, Pugnoides ottumwa, and Composita trinuclea, the pelecypod Allerisma, the spiny solitary rugose coral "Zaphrentis" pellaensis, and the less common small blastoid Pentremites conoidea are among the many forms represented. There are abundant crinoid stems and many bryozoans. An interesting ecologic feature is the common occurrence of bryozoans encrusting crinoid stems. All stages of growth of bryozoan colonies may be observed, from a thin layer through which the annulations of the crinoid stem can still be seen, to colonies an inch or two in diameter in which the crinoid stem can be seen only by breaking the specimen. Occasional specimens of the trilobite Phillipsia may also be found, generally just the pygidia or, less commonly, the cephalon.

Route to the next stop: Return to U. S. Highway 63 and turn south (left) back into Oskaloosa and the intersection with State Highway 163. Turn northwest (right) on Highway 163 and continue about 17 miles to Pella. Turn south at Pella on a gravel road (not County Road P) and continue

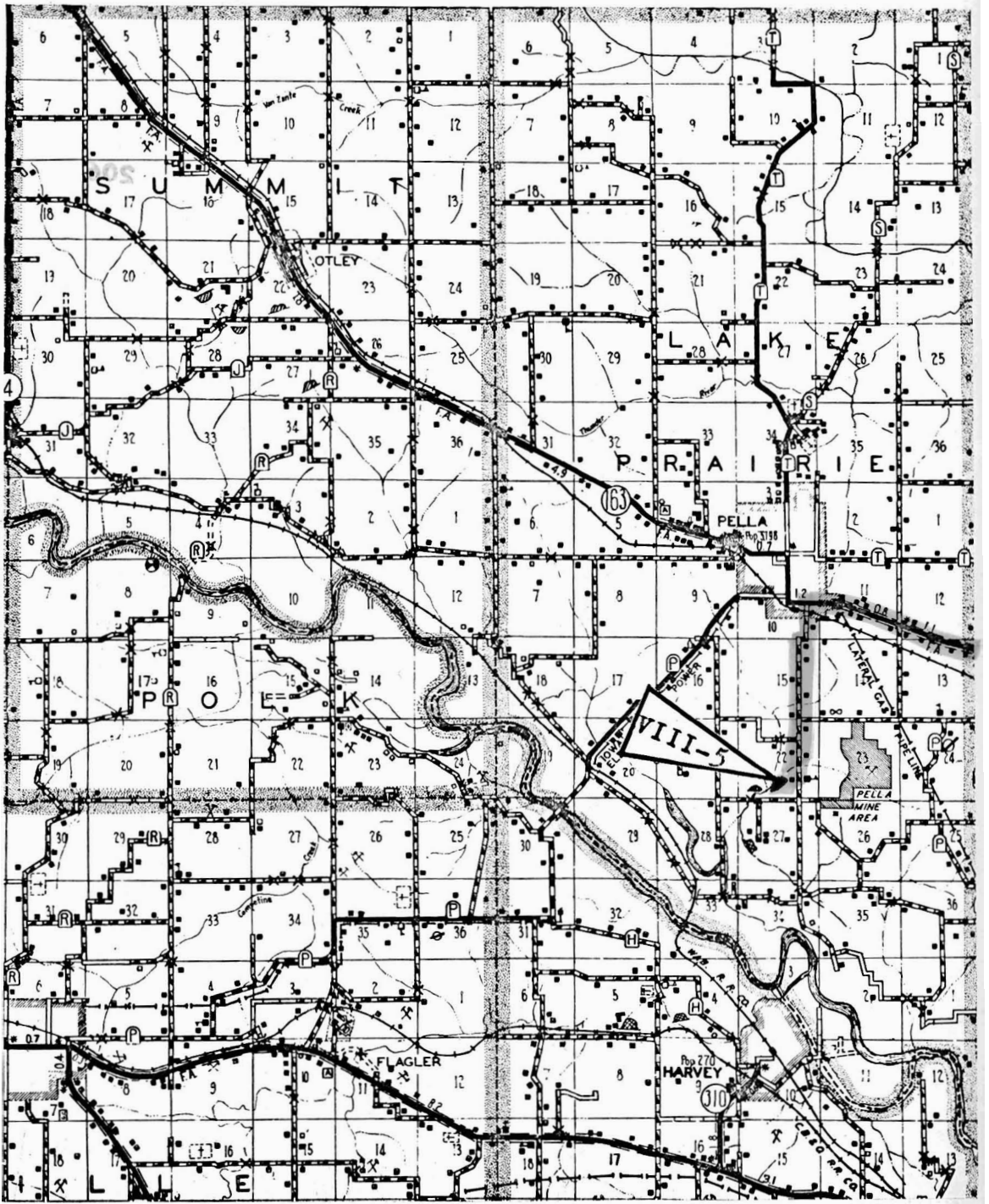


Fig. 54. Map of Pella Area

about two miles or less to a quarry on the west side of the road for Stop 5 (see Fig. 54).

Stop 5. Pella Quarry, Marion County. This quarry [SW 1/4, SE 1/4, Sec. 22, T. 76 N., R. 18 W., Marion County] is only one of a large number in the Pella area, most of which were operated as coal mines in the Pennsylvanian Des Moines Series. This particular quarry does not contain the Pennsylvanian beds, but carries the rich Pella fauna described at Stop 4. Collecting is easiest in the gentler, more weathered slopes. A grass-covered slope above the upper-level lift of the old quarry is a source of blastoids, particularly in the early spring, after rains. Large nodules of pyrite occur at definite horizons in the quarry, and are best reached when the water in the quarry is frozen in winter.

It is instructive to compare the types of organisms represented (phyla, classes, orders and families), their ecologic relationships and the type of rock in which they are found at Pella with the situation in the older Lime Creek Formation as displayed at Rockford.

The Pennsylvanian material may be collected in another pit a short distance to the southwest. Lepidodendron and other

plant remains have been secured from this pit, which is now used as a dump. Extreme caution should be shown when collecting in such an area.

A survey has been made of most of the Mississippian units of southeastern Iowa; particular attention is drawn to the relationship of organisms and rock type, and of rock type with preservation.

Fig. 55. Trip II  
Route Map





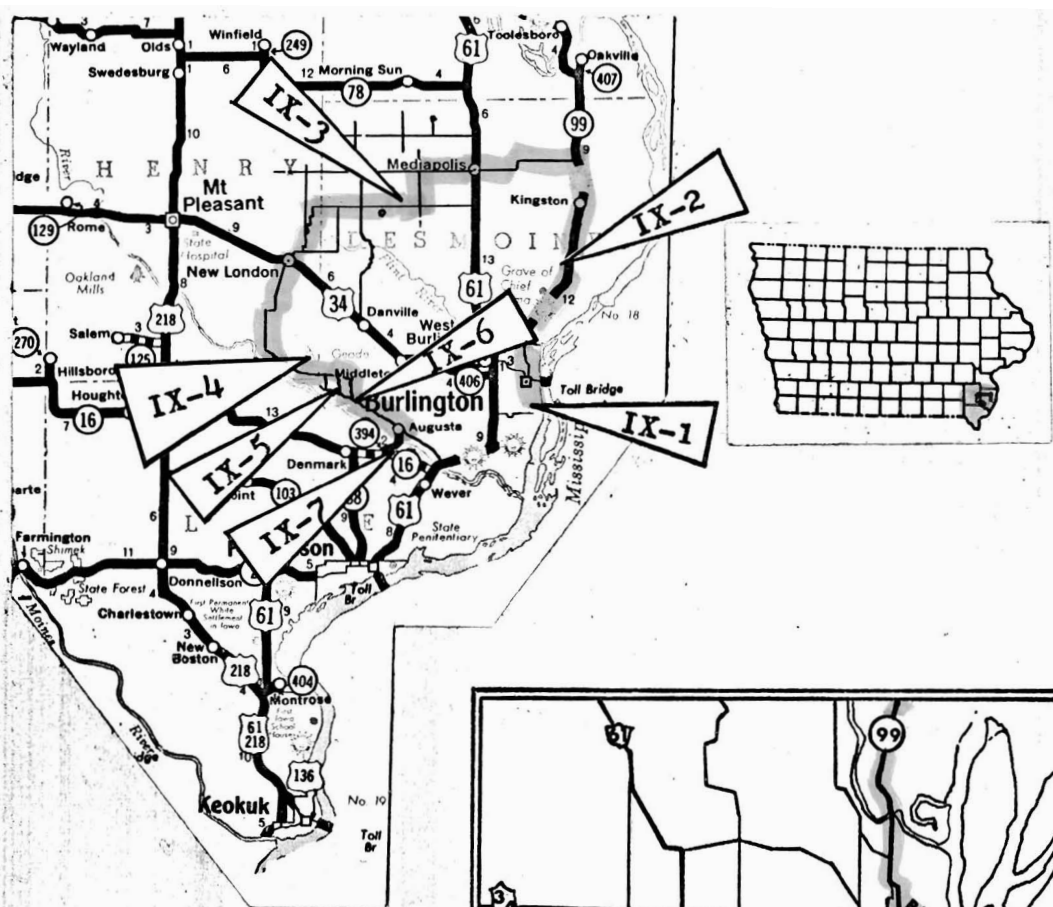


Fig. 55. Trip IX  
Route Map

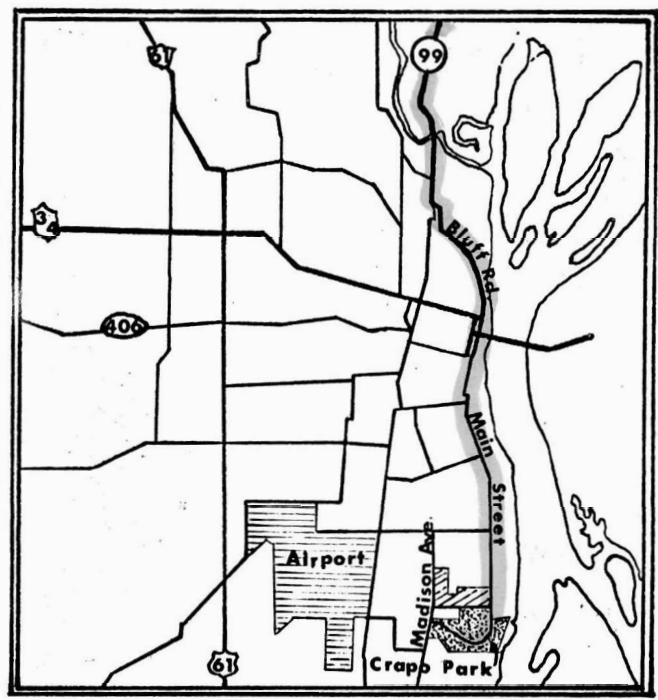


Fig. 55a. Burlington City Map

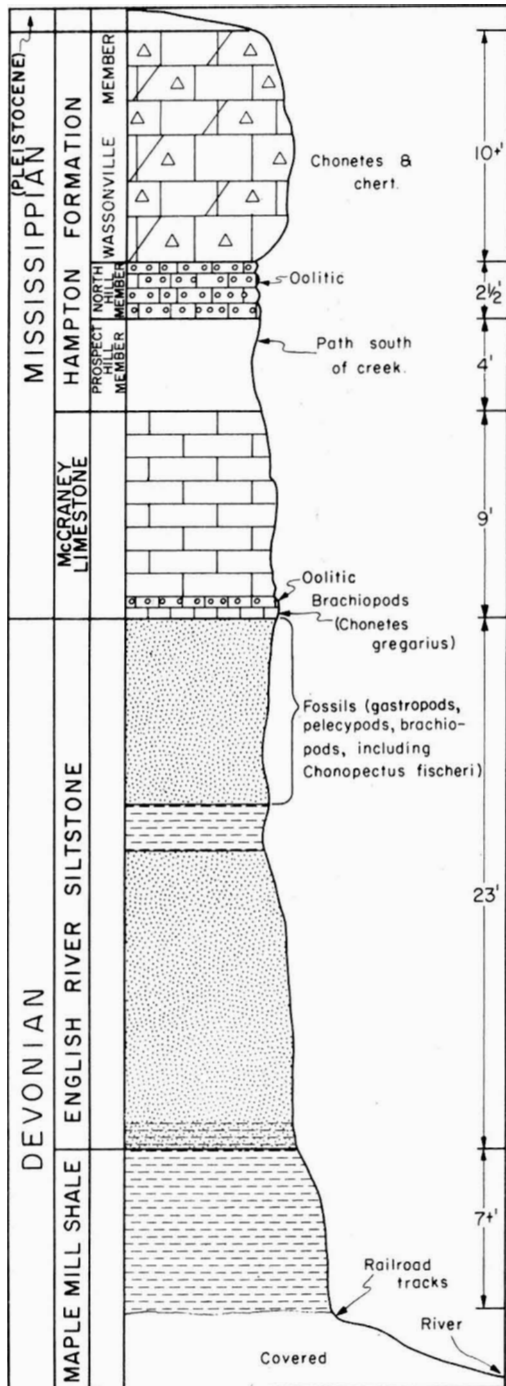


Fig. 56. Section at Crapo Park, Burlington

## TRIP IX

### MISSISSIPPIAN

#### Southeastern Iowa

Assembly is suggested at Crapo Park, in the southern part of the city of Burlington. The park is located between Madison Avenue and Main Street (see Fig. 56). This will also be the first stop. The seven suggested stops for this trip (see Fig. 55) will require a very full day.

Stop 1. Crapo Park, Burlington, Des Moines County. Along the bluffs in the park [NW 1/4, Sec. 16, T. 69 N., R. 2 W., Des Moines County] is exposed a section from the Upper Devonian through the top of the Lower Mississippian (Kinderhook). At the base of the bluff, between the railroad track and the English River Siltstone is a fresh exposure of the Upper Devonian Maple Mill Shale. The overlying English River Siltstone is also referable to the Upper Devonian, although diagnostic fossils are rare. Near the middle of the 23 feet of siltstone (see Fig. 57) is a shaly zone about a foot and a half thick, and at the top is the richly fossiliferous "Chonopectus Zone", crowded with the brachiopod Chonopectus fischeri, spiriferids, and

various molluscs. These fossils are preserved as casts and molds in the bright yellow siltstone. [Note that collecting is not permitted in the park, although loose specimens may be obtained in talus along the railroad embankment south of the park proper.] Overlying the English River Siltstone is the McCraney Limestone. Most of the nine feet of sublithographic and partially dolomitic limestone of this formation largely covered in the park, although some ledges project through the leaf-mold and general ground-cover. A thin zone (about half a foot) at the contact with the underlying English River Siltstone is exposed, however, and is generally rich in brachiopods (in particular Chonetes gregarius) and is somewhat oblitic at the top. Spiriferids and productids are among the fossils here.

Overlying the McCraney Limestone (the contact is difficult to see) is a unit, generally considered part of the Hampton Formation, the Prospect Hill Siltstone. The lower portion of this four-foot siltstone is partly covered where it lies below the level of the path in the park, but the alternating silt and shale layers may be seen exposed for about a foot above the path south of the creek in the park. Two and a half feet of the North Hill Member of the Hampton Formation lies above the Prospect Hill. This unit is thought to be

the equivalent of the Chapin Member of the same formation in north-central Iowa. Here it is obolitic; the obolites are less well-developed at the type section of the Chapin (see Trip VI, Stop 2). The top 10 or so feet of the section in the park are placed in the Wassonville Member of the Hampton Formation, equivalent of the Maynes Creek Member of north-central Iowa. This yellowish-brown dolomitic limestone contains many white crinoid stems in certain layers, producing a distinctive mottled appearance. Some of the chert layers in the Wassonville Member contain whole silicified crinoids.

The age of both the Maple Mill Shale and the English River Siltstone has been a subject of much debate. The Maple Mill Shale contains few megafossils, and formerly thought by many authorities to be Lower Mississippian (Kinderhook). Recent studies on conodonts has indicated an Upper Devonian age for the formation. The conodonts of the English River Siltstone at its type section along the English River near Kalona are Lower Mississippian. However, ammonoid cephalopods found in the formation at Crapo Park are Upper Devonian, indicating that the English River is of different ages at different localities. This illustrates a time-transgressive unit. Evidently, the same sort of silty

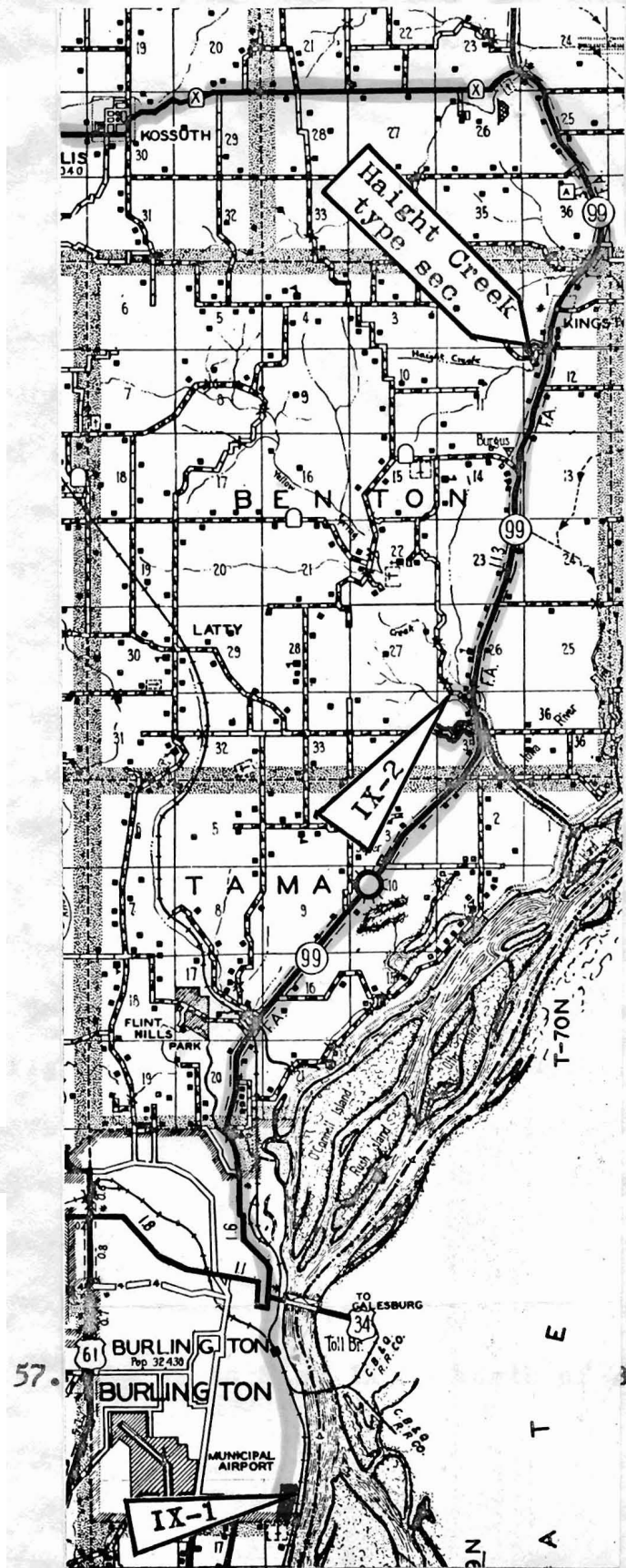


Fig. 57.

Burlington

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material was being deposited in the easternmost part of the state in the Late Devonian, and farther west during the Early Mississippian; this material now forms a single rock unit.

Most of the rock units exposed in Crapo Park will be seen at the next stop, where collecting will be permitted.

Route to the next stop: Leave Crapo Park northward via Main Street. Follow Main Street into the center of town, past the Mississippi River Bridge and on to where it becomes Bluff Road. Continue north along Bluff Road, noting exposures of English River and Maple Mill at the base of the bluffs. Bluff Road joins State Highway 99 (Des Moines Avenue) and continues north. Follow State Highway 99 north out of Burlington about six miles beyond the City Limits to a cross-roads intersection with a gravel road by a leveed stream running eastward to the Mississippi. Turn left at the cross-roads and continue about one-tenth of a miles, and park anywhere convenient for Stop 2.

Stop 2. Creek and Road Bluffs, southeastern Benton Township, Des Moines County. At this stop [NW 1/4, Sec. 35, T. 71 N., R. 2 W., Des Moines County] and along several creeks in the

vicinity, a section from the Upper Devonian to the lower part of the Lower Middle Mississippian (Osage) is exposed. About seven feet of the Dolbee Creek (lowest) Member of the Burlington Limestone of Osage age overlies six to seven feet of the Wassonville Member of the Hampton Formation (Kinderhook) along the road. The brachiopod Chonetes, and crinoid stems and rare cups or whole specimens occur in the Wassonville, the best-preserved specimens being found in the weathered chert bands.

In the bluffs along the creek may be found, in descending order, three and a half feet of the North Hill Member of the Hampton Formation, six feet of the McCraney Limestone, and eight feet of the English River Siltstone. These units are essentially the same as at Crapo Park, except that the Prospect Hill Siltstone is missing. The Maple Mill Shale is well exposed in a bluff and roadcut along the next west-bearing gravel road to the north, off State Highway 99.

Route to the next stop: Return to State Highway 99 and turn north; continue about eight and one-half miles to the intersection with County Road X. [Note: there are almost no signs on County roads in Des Moines County; use the County Highway maps.] On the way, note, just south of the community of Kingston, in a bluff about 300 feet west of the





Fig. 58. Map of Pleasant Grove Area

bridge across Haight Creek, the type section of the Haight Creek (middle) Member of the Burlington Limestone. This same member can be seen in a quarry near the intersection of State Highway 99 and County Road X, and will be visited in another quarry at the next stop. Turn west (left) on County Road X and continue about six and a half miles to Mediapolis and the intersection with U. S. Highway 61. Cross Highway 61 and continue about another three and a half miles to the intersection with a north-south gravel road, County Road T (no sign on road -- see Fig. 58). Turn south on County Road T and continue two miles to the intersection with County Road P, an east-west gravel road (no sign on road). Turn west (right) on County Road P and continue a little over one mile to Leonhard (Kaser) Quarry on the north (right) side of the road for Stop 3.

Stop 3. Leonhard (Kaser) Quarry, Des Moines County. At this quarry [SE 1/4, Sec. 1, T. 71 N., R. 4 W., Des Moines County] the entire Burlington Limestone is exposed, and small portions of the underlying Wassonville Member of the Hampton Formation and the overlying Keokuk Limestone can be seen.

The Burlington Limestone is famous for its crinoids, among

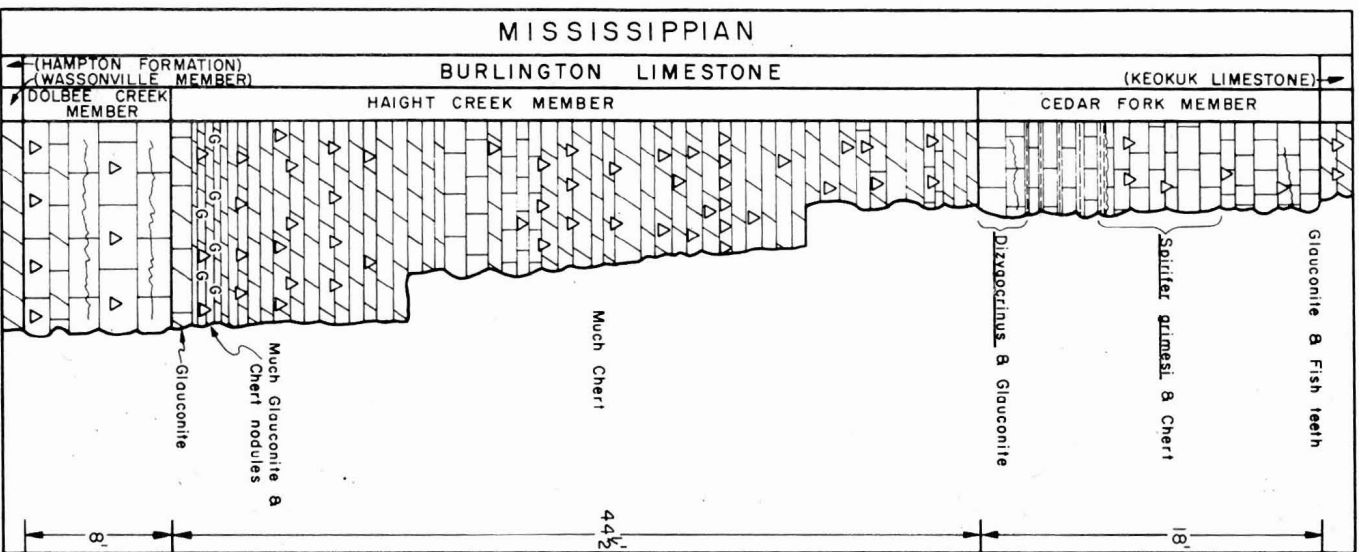


Fig. 59. Section at Leonhard Quarry

them Dizygocrinus, which occurs in particular concentrations along with the mineral glauconite in a zone at the base of the Cedar Fork (upper) Member of the Burlington Limestone. Batocrinus and other crinoids may also be found; whole cups are not uncommon. The brachiopod Spirifer grimesi also occurs, and is an index fossil for the Burlington. It is particularly abundant in the middle of the Cedar Fork Member (see Fig. 59). Glauconite occurs in various beds throughout the formation, and many of the layers are dolomite, particularly in the Haight Creek (middle) Member, which also contains much chert. There is some chert in the Dolbee Creek (lower) Member, and also in the part of the Cedar Fork Member where the Spirifer grimesi is most abundant. At the top of the Burlington Limestone, at and just below the contact with the overlying Keokuk Limestone, there is a zone rich in fish teeth. Parts of the Burlington Limestone consist of up to 70% of crinoid fragments. Even where the fossil material is no longer recognizable, it is fairly certain that the bulk of the limestone is formed from the remains of organisms, mostly crinoids.

This quarry is the type section of the Cedar Fork (upper) Member of the Burlington Limestone. The member is named for

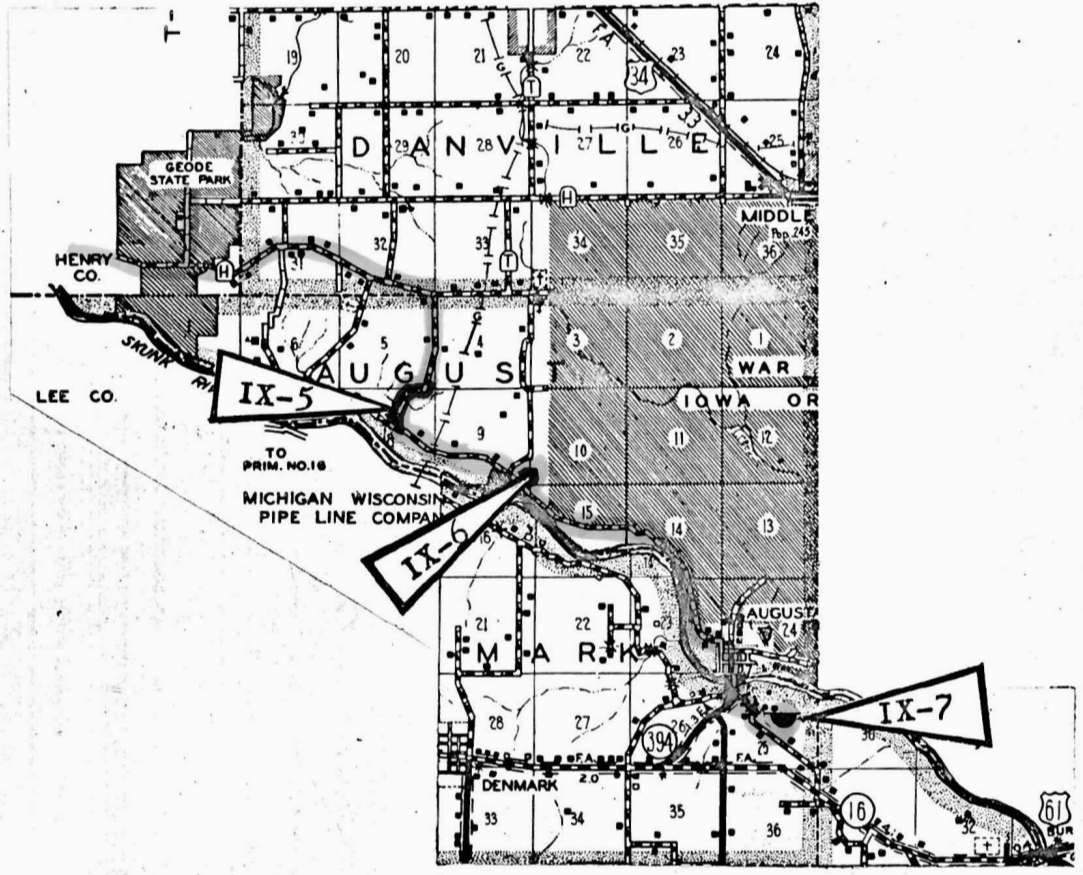


Fig. 60. Map of Geode State Park-Augusta Area

Cedar Fork Creek, on whose banks the quarry is excavated. If time permits, investigation of the creek exposures would be interesting.

Route to the next stop: Continue west on County Road P into Henry County (the road letter remains the same across the County line) a total of about seven miles to New London and the intersection with U. S. Highway 34. Follow Highway 34 through the town, and turn south on County Road D near the western town limits. (There is no sign on County Road D; the intersection is opposite the water tower in the New London City Park, and a small sign indicates "Lowell" to the south.) Continue south on County Road D to the town of Lowell, and there turn east on County Road H towards Geode State Park, which will be Stop 4.

Stop 4. Geode State Park, Henry, Des Moines and Lee counties. The bulk of the rock in the park belongs to the St. Louis and Warsaw Formations, of Meramec and Osage (Upper Middle and Lower Middle Mississippian) age, respectively. The St. Louis is composed of limestones, and the Warsaw is mostly shale. Some of the Keokuk Limestone may be found in the stream bottoms. In the NW 1/4, Sec. 36, T. 70 N., R. 5 W., along the old road to the beach, is a Pennsylvanian

"outlier" or erosional remnant, composed of sandstones and shales, probably of the Des Moines Series.

The famous geodes of Geode Park were secured from the Warsaw Formation. Because of intensive collecting, they are now very scarce, and collecting in the Park is prohibited. These geodes are thought to have formed as concretions around an organic nucleus, with subsequent solution to form the central cavity (see above, MISSISSIPPIAN, General Remarks). The contact between the Warsaw Formation and the underlying Keokuk Limestone is marked by transition from dominantly shale lithology to a more nearly pure limestone. The St. Louis Limestone is somewhat sandy, commonly brecciated (broken and re-cemented) and generally lacks fossils; the Keokuk and Warsaw are both fossiliferous.

Route to the next stop: Leave Geode State Park on County Road H, bearing eastward. Continue about two and a half miles, passing two gravel roads leading south (right) off County H. Turn south on the third gravel road, and continue about one mile. Jog west (right) and park anywhere venient for Stop 5. (See Fig. 60).

Stop 5. Road cut between Geode Park and Augusta, Des Moines

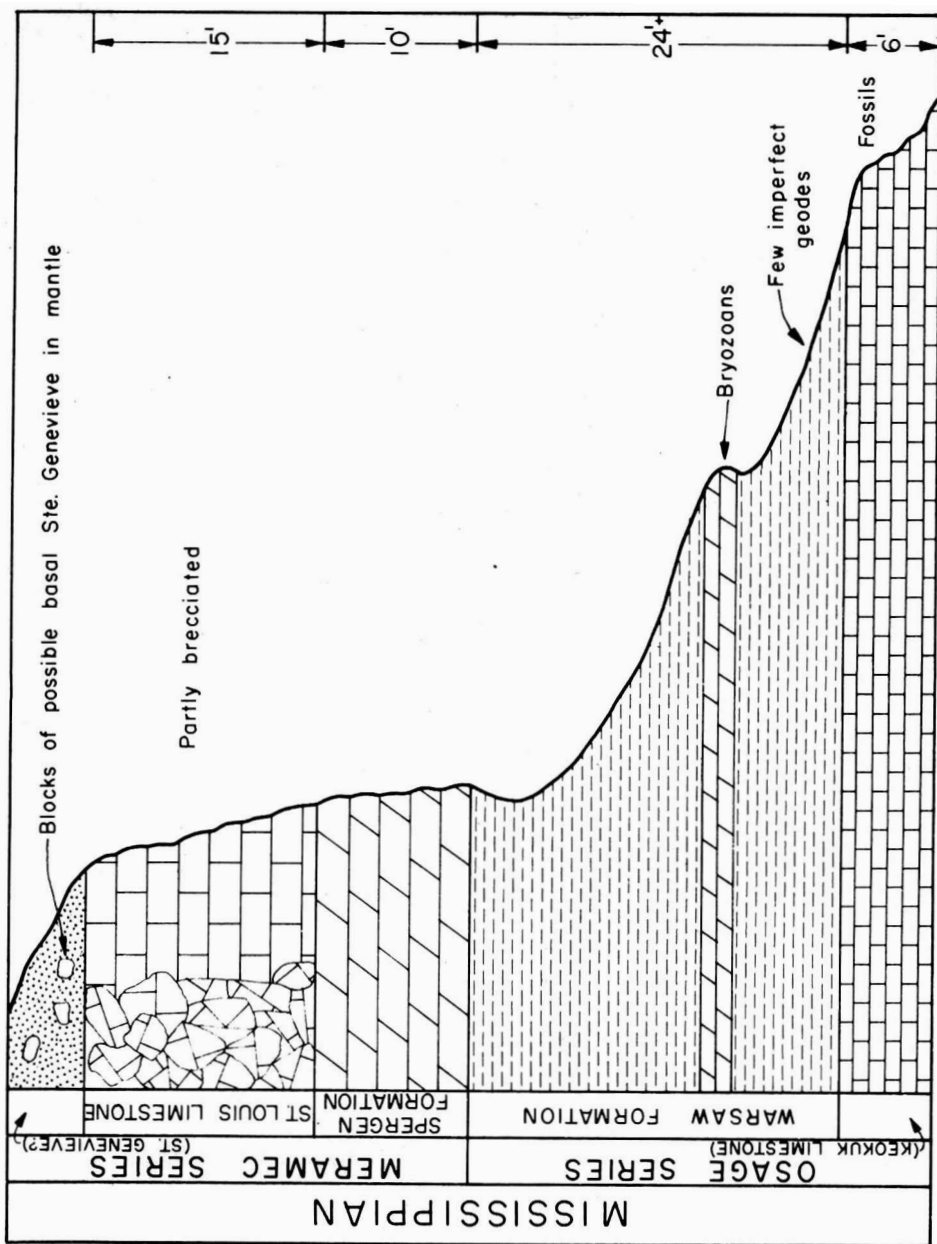


Fig. 61. Section Along Roadcut Northwest of Augusta



County. For about three-eighths of a miles along this road [W 1/2, NE 1/4, Sec. 8, T. 69 N., R. 4 W., Des Moines County] a sequences from the Keokuk Limestone (south end of the roadcut) to the Stl Louis and possible the Ste. Genevieve Limestone (north end of roadcut) is exposed.

At the south end of the section, where the road forms a T-junction with the Skunk River road, a little over six feet of the Keokuk Limestone is moderately well exposed. It contains brachiopods, bryozoans, crinoid stems and plates, and some corals. Spirifer keokuk and Athyris lamellosa are typical brachiopods of the formation; many fenestellid ("lacy" or "window") bryozoans are among those present.

Continuing north along the roadcut (see Fig. 61), about 25 feet of the blocky, light green-blue to blue-green shales of the Warsaw form a gentler slope which is largely covered with vegetation. The lower seven feet of the formation contains some partially-developed geodes, and the nest two feet are a dolomite, which contains numerous bryozoans. Among these may be the "corkscrew" fenestellid, Archimedes.

Overlying the Warsaw is ten feet of massive dolomite, placed generally in a separate formation named the Spergen Formation. This unit has been recorded sporadically in both

southeastern and north-central Iowa. The patchy distribution probably reflects the usage of different field workers, some of whom have separated this unit from the overlying St. Louis Limestone whereas others have not, rather than actual nondeposition or erosion of the unit. Along the west side of the road this and the overlying beds are flat-lying, but on the east side of the road, a small anticline (upward flexure) in the rocks may be seen.

The St. Louis Limestone is partly flat-lying and undisturbed, and partly brecciated and folded. It is thought that the brecciation, plus the folding in this and the Spergen Formation indicate two types of forces acting on these units. Some of the breaking of the St. Louis beds may be due to the action of waves, during or shortly after the time the beds were laid down. The folding, however, is thought to represent some minor earth movements occurring a short time after the beds were consolidated.

Above the twelve to fifteen feet of the St. Louis Limestone the bedrock is obscured by soil mantle. Some sandstone blocks are found in this mantle; they are thought perhaps to be from the lower, sandy part of the Ste. Genevieve Limestone which may lie concealed under the mantle at the top of the hill.

Route to the next stop: Continue east and somewhat south along the Skunk River road. A little over a mile to the southeast, another road runs northward. On both corners of this intersection there are quarries; the one on the northeastern corner is recommended for Stop 6.

Stop 6. Abandoned Quarry northwest of Augusta, Des Moines County. This quarry [SE 1/4, SE 1/4, Sec. 9, T. 69 N., R. 4 W., Des Moines County] is, for the most part, in the Keokuk Limestone, and contains an abundance of brachiopods, corals, bryozoans and crinoid stems. Athyris lamellosa, Torynifer pseudolineata, Spiriferina sp., and other spiriferid and productid brachiopods, various solitary rugose corals and some tabulate colonial corals of an aulopoid "trumpet-chain") type, and both fenestellid and branching or encrusting types of bryozoans may be secured. Many of the brachiopods and corals were somewhat flattened during lithification of the original sediments.

Route to the next stop: Continue on the Skunk River road into Augusta, and there cross the river. Bear diagonally left (southeast) on a gravel road and continue about half a mile to the Raid Brothers Quarry for Stop 7. (Permission should be secured in advance for this stop.)

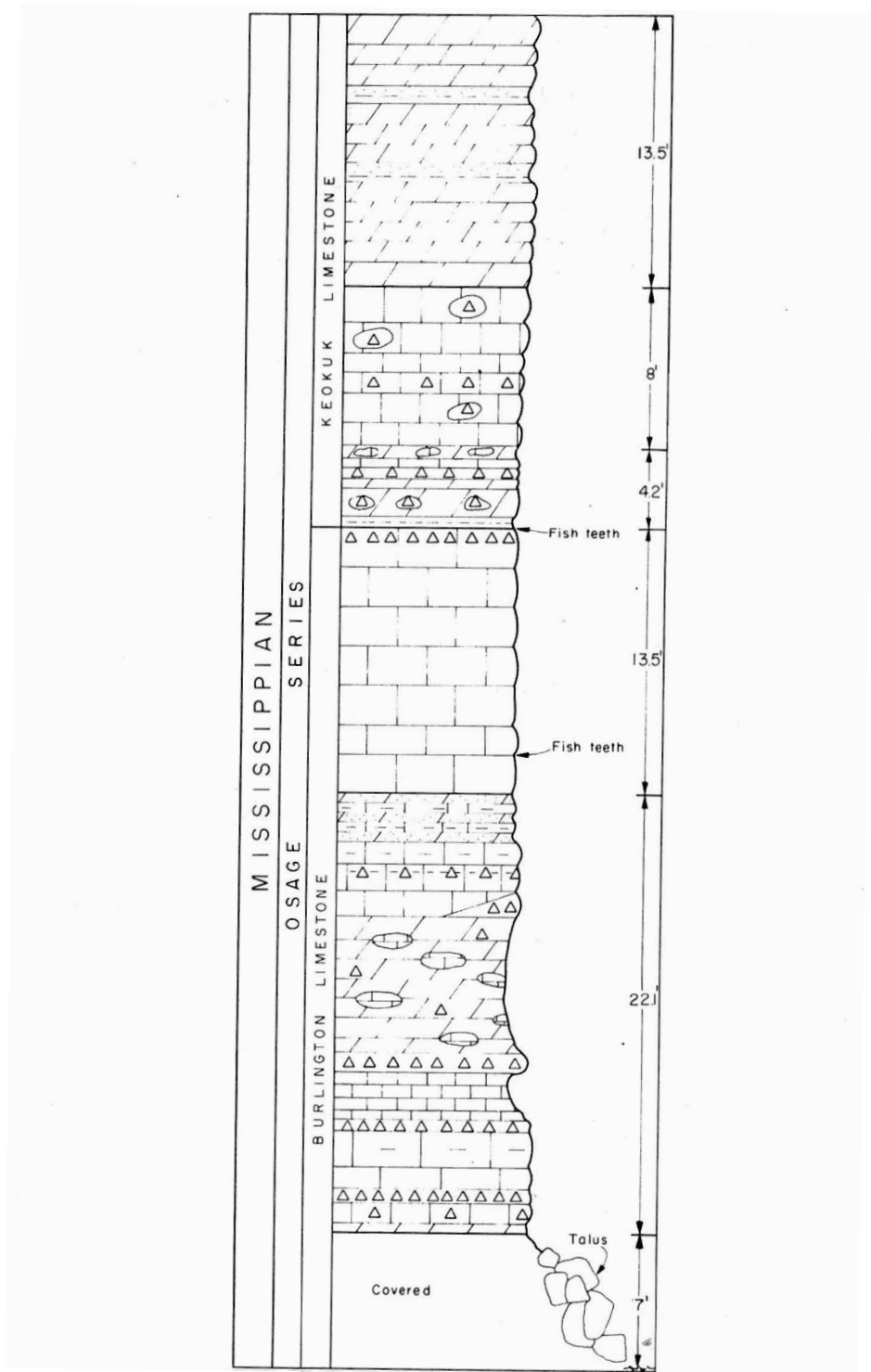


Fig. 62. Section at Raid Bros. Quarry, Augusta

Stop 7 (optional). Raid Brothers Quarry, Augusta, Lee County. Here [SE 1/4, NW 1/4, Sec. 25, T. 69 M., R. 4 W., Lee County] the quarry contains a complete section of the Burlington Limestone, and some of the overlying Keokuk Limestone, in a section similar to that seen at Leonhard Quarry. Crinoid cups have been collected from the Burlington at this quarry. About 23 1/5 feet above the level of the rubble pile adjacent to the quarry sump is a discontinuous layer of fish teeth, with a continuous layer about 11 1/2 feet above it at the contact with the Keokuk Limestone (see Fig. 62).

This is the last suggested stop. The entire Mississippian section for southeastern Iowa has been presented, and some of the problems connected with the establishment of the System have been discussed. The rich Mississippian fauna of Iowa, well-known throughout the country, has been seen. The exposures of rocks of this age along the Mississippi River from Burlington to St. Louis are the type area for the system, which takes its name from the river.

## SUGGESTED READINGS

### Books for Beginners

#### I. Paperbound

COLLINSON, CHARLES W., 1959, Guide for beginning fossil hunters: Urbana, Illinois State Geological Survey, Educational Series 4, 39 p.

COLLINSON, CHARLES, and SKARTVEDT, ROMAYNE, 1960, Field Book Pennsylvanian plant fossils of Illinois: Urbana, Illinois State Geological Survey, Educational Series 6, 35 p.

HURLEY, PATRICK M., 1959, How old is the Earth?: Garden City, New York, Anchor Books, Doubleday & Company, Inc., 160 p.

MATTHEWS, WILLIAM H., III, 1962, Fossils, an introduction to prehistoric life: New York, Barnes & Noble, Inc., 337 p.

RHODES, FRANK H. T., ZIM, HERBERT S., and SHAFFER, PAUL R., 1962, Fossils: New York, Golden Press, 160 p.

SIMPSON, GEORGE GAYLORD, 1953, Life of the past: New Haven, Yale University Press, 198 p.

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#### II. Hardbound

BEERBOWER, JAMES R., 1960, Search for the past: Englewood Cliffs, N.J., Prentice-Hall, Inc., 562 p.

FENTON, CARROLL LANE, and FENTON, MILDRED ADAMS, 1958, The fossil book: Garden City, New York, Doubleday & Company, Inc., 482 p.

RUTTEN, M. G., 1962, The geological aspects of the origin of life on Earth: Amsterdam and New York, Elsevier Publishing Company, 146 p.

Textbooks

## I. Physical Geology

PUTNAM, WILLIAM C., 1964, Geology: New York, Oxford University Press, 480 p.

STRAHLER, ARTHUR N., 1963, The Earth Sciences: New York, Harper & Row, 681 p.

## II. Historical Geology

CLARK, THOMAS H., and STEARN, COLIN W., 1960, The geological evolution of North America: New York, The Ronald Press Company, 434 p.

DUNBAR, CARL O., 1949, Historical geology, 2nd ed.: New York, John Wiley & Sons, Inc., 500 p.

KUMMEL, BERNHARD, 1961, History of the Earth: San Francisco, W. H. Freeman and Company, 610 p.

MOORE, RAYMOND C., 1958, Introduction to historical geology, 2nd ed.: New York, McGraw-Hill Book Company, Inc., 656 p.

## III. Paleontology

EASTON, W. H., 1960, Invertebrate Paleontology: New York, Harper & Brothers, 701 p.

MOORE, RAYMOND C., LALICKER, CECIL G., and FISCHER, ALFRED G., 1952, Invertebrate Fossils: New York, McGraw-Hill Book Company, Inc., 766 p.

ROEMER, ALFRED S., 1945, Vertebrate Paleontology, 2nd. ed.: Chicago, Chicago University Press, 687 p.

SHROCK, ROBERT R., and TWENHOFEL, WILLIAM H., 1962, Principles of Invertebrate Paleontology, 2nd ed.: New York, McGraw-Hill Book Company, Inc. p.

## References for Fossil Identification

### I. General

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### II. Restricted

LADD, HARRY S., 1928, The stratigraphy and paleontology of the Maquoketa Shale of Iowa: Iowa Geological Survey, v. 34, p. 305-448. Out of print.

FENTON, CARROLL LANE, and FENTON, MILDRED ADAMS, 1924, The stratigraphy and fauna of the Hackberry stage of the Upper Devonian: Contributions from the Museum of Geology, The University of Michigan, New York, The MacMillan Company, 260 p. Out of print.

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## General References

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AMERICAN GEOLOGICAL INSTITUTE, 1957, 1962, Dictionary of geological terms: Garden City, New York, Dolphin Books, Doubleday & Company, Inc., 545 p.

### II. Hardbound

CHALLINOR, JOHN, 1964, A dictionary of geology, 2nd ed.: New York, Oxford University Press, 289 p.

## References for the Advanced Collector



KUMMEL, BERNHARD, and RAUP, DAVID, eds., 1965, Handbook of Paleontological Techniques: San Francisco, W. H. Freeman and Company, 852 p.

MOORE, RAYMOND C., ed., 1953 to date, Treatise on invertebrate paleontology, Parts A - X: Lawrence, Kansas, Geological Society of America and University of Kansas Press.

In addition, the serious collector looking for more detail than available in these references might consult the County Reports published by the Iowa Geological Survey, the Proceedings of the Iowa Academy of Sciences, and the Guidebooks for the annual Tri-State Geological Field Conferences. These references are available in the library of the State University of Iowa, Department of Geology.